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## UNIVERSITY PLANNING IN GREAT BRITAIN

IN replying to the debate on the development of the universities in the House of Lords on May 14, the Lord Chancellor said little that added to what is already known regarding the plans and intentions of the Government. Nevertheless, in referring to the comparisons which are continually being made about the size of the university population in Great Britain and other countries, he did well to emphasize that such comparisons can be misleading "unless one realizes exactly what is meant by university education". The real meaning of that extraordinary American figure of one in 125 going to a university is rarely understood. In expressing his belief that there is a strong case for following the Americans "in having whole-time education up to university age", Lord Lindsay of Birker categorically declared that "many of the institutions to which these American undergraduates go we should not consider universities". Discussing the problems raised by the existence of these institutions, Dr. R. M. Hutchins, chancellor of the University of Chicago, wrote recently in *The Observer* : "The United States has led the way in providing education for all the people, and this provision is certainly a milestone on the march along what is called the Democratic Way of Life. In fact, however, this provision is both too little and too much. It is too little because it rests on the assumption that if no or low fees are charged education is free. It is too much because it is indiscriminate."

It was not, however, for purely academic reasons that the Lord Chancellor resisted the plea of Lord Lindsay of Birker that an independent Government Committee should be appointed to review university policy. The refrain of his speech was that the powers of the University Grants Committee have been so extended that it is now able "to assist, in consultation with the universities and other bodies concerned, the preparation and execution of such plans for the development of the universities as may from time to time be required in order to ensure that they are fully adequate to national needs" ; and that, since there is no immediate likelihood of the latest estimates of the needs of the universities prepared by the University Grants Committee being met, nothing is to be gained by the appointment of another committee. "The real trouble," said the Lord Chancellor, "is the building problem" ; and, as this is no short-term problem, the outlook is indeed gloomy. The University Grants Committee estimates that the developments which the universities are willing to undertake in the next five years will require £50,000,000, four-fifths of which is for the erection and equipping of new buildings. While the Chancellor of the Exchequer has accepted that estimate and expressed his willingness to find the money, the Minister of Works does not believe that, even if university building is given a high priority, more than £20,000,000 of building will be possible in this period. The most that he is prepared to promise is that he is willing to review the position from year to year.

This emphasis which the Lord Chancellor chose to place on the building problem has had the unfortunate effect of obscuring the larger and more fundamental questions which Lord Lindsay of Birker raised in opening the debate. Are we quite sure that the present framework of university education should be merely perpetuated? Is there not room for further experiment? Is there a place for institutions like the *Écoles des Sciences Politiques* or *des Études Polytechniques* of France, or the great German *Handelshochschule*? Are the schools providing enough boys and girls of the right type to permit a doubling of numbers in the universities without a lowering of standards? Is there any assurance of a demand for their services once they have passed through the universities? These are, in the view of Lord Lindsay of Birker, some of the questions which require investigation; and it is scarcely surprising that he should ask whether a committee the business of which it is year by year to consider grants to the universities is "the best committee to look at the whole set-up, with the idea, perhaps, of some revolutionary change".

One difficulty in charging the University Grants Committee with the responsibility of making policy decisions is what *The Economist* has called its "passive acceptance" of the suggestions offered by the universities and the Committee of Vice-Chancellors and Principals. "It could never," says *The Economist*, "compel London University to break itself up against its will; neither is it prepared to go against the advice of the Vice-Chancellor's Committee that it is better to concentrate resources in the existing institutions than to dissipate limited reserves of personnel and materials on entirely new ones." Although it has given favourable consideration to the proposed experiment at Stoke-on-Trent, the wording of the resolution which has been communicated to the sponsors of the scheme deserves to be noted: "That the committee would consider sympathetically an application for financial assistance in respect of a new university college in North Staffordshire, provided that the basis of studies in science and art be adequately broadened". And again: "If this scheme is to include the conferment of degrees by the college, the committee will wish to be satisfied that adequate arrangements have been made for sponsorship by a university or universities". In short, although the promoters of the scheme drafted it in the belief that "a local university college should have a close relation to the distinctive characteristics of the locality it serves", the University Grants Committee has, in effect, replied that there must be more evidence of conformity to the *status quo*. In making this request the Committee may be wise; but, if *The Economist* is right in its assertions, it is not easy to believe that the proposals have been subjected to impartial and independent examination.

Even more difficult—and certainly not less pressing—is the problem of the co-ordination of the work of the universities and technical colleges; and its speedy solution would seem impossible without the creation of such a committee as Lord Lindsay of Birker requested. Indeed, it might well be argued that the full and satisfactory implementation of the findings of the Percy Committee on Higher Technological Education will otherwise prove impracticable. While that Committee did recommend the selection of a strictly limited number of technical colleges in which there should be developed technological courses of a standard comparable with that of university courses, Lord Eustace Percy alone suggested that the Government should adopt the policy of developing certain colleges into major university institutions. It may be true, as the Lord Chancellor hinted, that, "if the recommendations of the Percy Committee for a National Council of Technology are implemented (as there is every reason to think they may be), it would be one of the functions of that council to consider whether such a policy of up-grading is feasible, and if so, how it could best be carried out"; but what guarantee at present exists that the status of university institutions would not be denied to those colleges which were up-graded unless "the basis of studies in science and art be adequately broadened"?

Yet another aspect of this problem of the need for a body specifically charged with the task of co-ordinating policy was noted by Dr. Eric James, high master of Manchester Grammar School, at the conference on "The Place of Universities in the Community" arranged by the British Association and held at the University of Manchester on May 10. As already noted in *Nature* (of May 24), Dr. James urged that the work of the Barlow Committee is incomplete because no evidence was taken from schools as to their capacity to provide the requisite number of potential science graduates. In assuming that there is a waste of intelligence and talent, he may be right; and, if he is, there is a pressing need to discover at what stage of education the wastage occurs. On the other hand, Lord Lindsay of Birker does not share this view. In discussing the extension of secondary education under the Education Act, he remarked: "As anyone concerned with education—particularly secondary education—is aware, the problem which arises from this reform is: Can we combine a high standard of English secondary education with a great increase in numbers—a threefold increase in numbers? . . . I do not believe we could, for one moment, have multiplied the pupils going to grammar schools without affecting the standard of the grammar schools."

Important as this question undoubtedly is, it is even more important to know the real requirements of the nation for different kinds of scientific, technical, professional and managerial skill. Although certain professional bodies have made their own estimates—the Ministry of Education for teachers and the Good-enough Committee for medical men—neither the Barlow Committee nor the Hankey Committee tried to break up the whole requirements into detailed specialities. More recently, the Urwick Committee, in its report on "Education for Management" (H.M. Stationery Office. 6*d*.), has failed lamentably to find answers to the vital questions—the numbers engaged in management, the future demand for managers, and the experience of training for management gained in other countries. Without some clear indication of the national need for physicists, chemists, metallurgists,

statisticians, economists or managers it is impossible for the universities to know whether they are over-expanding or under-expanding particular departments. It may, for example, be the sheerest folly to insist that "the basis of studies in science and art be adequately broadened", and that the traditional balance of studies should continue to be maintained. The answer to these questions will not be found until some body has the primary responsibility of co-ordinating and expanding the findings of existing reports and of presenting a comprehensive picture of the needs and opportunities in the field of higher education.

Least of all should it be forgotten that the task of university education is not to transmit an established body of knowledge. The university must do infinitely more than teach facts and theories. It must help the student to develop his faculties ; it must train him to think independently that he may form his own judgments ; and it must teach him methods of study that will enable him to keep pace with developments. In the medieval *disputatio* professor and students discussed a subject, weighing the pros and cons of an argument. While that form of teaching has its modern counterpart, the expansion of scientific teaching has resulted in new forms of academic instruction unknown to the medieval university. These methods are as applicable to the social as to the natural sciences. Political science divorced from field work in parliaments and government offices cannot be taught efficiently. Economics is a dead subject if the student has no opportunity to watch the process of production and distribution in mines, factories, shops, and the stock exchange ; and if sociology is to be more than the philosophy of history it requires still more extensive field work. These principles are accepted in theory. How far they are being applied is still another question that requires to be answered.

## TRIUMPHS OF THE BIRD PHOTOGRAPHER

### Masterpieces of Bird Photography

Edited by Eric Hosking and Harold Lowes. Pp. 144 (63 plates). (London : Wm. Collins, Sons and Co., Ltd., 1947.) 12*s.* 6*d.* net.

HAD this book been published in 1939 I believe we should have seen a higher standard of reproduction of the various outstanding photographs of birds which render it a remarkable volume. But the difficulties of post-war production are not the only ones which cropped up—some of the negatives of the earlier photographers have been irretrievably lost, and reproduction had to be made from existing prints. That fine photograph, for example, of the pair of golden eagles at the eyrie together, taken by the late A. J. Rooker Roberts, would, I am sure, have been much better reproduced had the negative been found. The book is largely the work of members of the Zoological Photographic Club, to which the volume is dedicated. The birds shown are all British birds, although some of them have been photographed abroad. The reproduction of the snow goose, for example, was taken in Greenland by the late David Haig-Thomas, and William Farren's spoonbill was secured in the Marismas of Andalusia.

As is perhaps unavoidable, the standard of the photographs is uneven ; some are without distinction, but a considerable number are good and some of them are excellent. To my mind, for sheer beauty and artistic perfection, the photograph of the kittiwake on the wing, taken by John Barlee, is supreme.

Some of the photographs reproduced are historic. We are shown, for example, what is the first ornithological photograph taken—that of a song thrush's nest by the late Cherry Kearton, exposed on April 11, 1892—fifty-five years ago. Here, too, is reproduced the first photograph ever taken of a bird on the nest—the bird is a lapwing, and was photographed by the late R. B. Lodge in 1895, by remote control, for 'hides' had not then been invented. All of us who are bird photographers are in the debt of that grand pioneer in Nature photography, the late Richard Kearton, who did more than any man to encourage a love for birds. Some of his photographs are still outstanding ; but many of his best negatives have been lost, otherwise a more striking one than that here reproduced—a bullfinch on the nest—might have been chosen. Curiously enough, I was the means of that picture being taken. The bullfinch was nesting in our garden in Aberdeenshire and was so tame that she sometimes rose from the nest to take hemp seed held between my lips. I was a boy at the time (the date of the photograph, by the way, is earlier than that mentioned, 1908) and had telegraphed Kearton to come and photograph a ptarmigan's nest which I had found. One of Kearton's legs, on account of a fall from a tree, was six inches shorter than the other, and few persons with that handicap would have climbed to a height of more than 3,000 feet. The climb took us all night, and Kearton carried his heavy camera on his shoulder, on its stand all ready for use.

The Kearton brothers—Richard and Cherry—were the first to see the possibilities of a 'hide' for bird photography, and experimented with one made of the skin of an ox stretched over a hollow frame.

Perhaps the most interesting photograph in the book, from a historic point of view, is that taken by the late Cherry Kearton of a pair of ospreys at their tree eyrie on Loch Arkaig, one of the last British nesting haunts of this beautiful bird, now lost to us through the inroads of the man with the gun and the egg collector.

Most of those whose photographs illustrate this book are members of the Zoological Photographic Club : one misses the work of certain well-known photographers, such as R. M. Lockley, who has taken some remarkable shearwater photographs.

Most of the photographs are of birds at the nest, but on page 49 there is a striking picture, which it must have taken great patience to obtain, of a mixed party of knot, curlew, oyster-catcher and bar-tailed godwit at the edge of the tide. It is a really remarkable photograph, and can be appreciated to the full only by bird photographers themselves. Of the outstanding photographs of birds at the nest there is, on p. 55, an excellent photograph of a female hen-harrier at the nest by T. M. Fowler, and, on p. 69, a remarkable photograph of a male Montagu's harrier carrying home food. This was taken by Walter E. Higham. Eric Hosking lives up to his high standard of bird photography by his picture (p. 73) of a barn owl taken by flashlight. Fred Jefferson shows (p. 77) a fine photograph of a water ousel,

taken at close range, bringing a billful of food to her family, and Arthur Gilpin (p. 63) has been most successful with a very difficult subject—a tree creeper.

Two photographs from the portfolios of the late G. B. Kearey are shown, one of them a singularly beautiful picture of a hen capercaillie—a shy and difficult bird to photograph—approaching the nest.

We are shown the late C. J. King's classic photograph of a greater black-backed gull, taken so long ago as 1910—a grand picture. One of the most beautiful photographs in the book is that of a sand-martin taken by L. H. R. Lowes; one cannot look too long at it. Perhaps the rarest photograph, which must have been most difficult to take, is that (p. 99) of a chough, taken by W. W. Nicholas. The chough, nesting in caves, is a hard bird to picture, and I do not remember having seen a good photograph of it before. Niall Rankin's classic photograph of a gannet alighting at the Bass Rock appears on p. 107. A remarkable study is J. E. Ruxton's picture of a pair of black-throated divers sitting side by side on the nest; the 'happy expression' on the face of one of the birds is clearly seen. H. Morrey Salmon's photograph of a pair of herons at the nest is a delicate and attractive piece of work. On p. 119 is a remarkable photograph of a swallow in flight taken by J. A. Speed, and on p. 131 Ian M. Thomson has an excellent picture of a pair of Montagu's harriers.

Finally, Hugh G. Wagstaff's skill in bird photography is seen in two outstanding photographs—one of a buzzard eating a rabbit on a hillside, the other of a pair of merlins exchanging forceful remarks at the nest.

This is one of the most interesting bird books that have been published for a long time.

SETON GORDON

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# THE CLINICAL ASPECT OF PREVENTIVE MEDICINE

## Preventive Medicine and Public Health

By Prof. Wilson G. Smillie. Pp. xvi+607. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1946.) 6 dollars; 30*s.* net.

PREVENTIVE medicine is the offspring of clinical medicine. Thomas Sydenham re-interpreted the Hippocratic conception of epidemics and led the way to the domain of modern epidemiology. The science of preventive medicine began in the eighteenth century, through the work of medical practitioners, like Huxham, Mead, Heberden, Fothergill, Haygarth, Willis and Withering, observers of the clinical features of epidemic disease, the influences of external environment, the paths of contagion and infection, and the effects of climate and season. University education in preventive medicine was initiated in 1768 by Johann Peter Frank, director of public health in Austrian Lombardy, and his international fame led to the creation of the first chair of public health in the University of Edinburgh.

Unfortunately, the specialization of public health for a considerable time brought about a dichotomy between preventive and clinical medicine. This was partly due to the beliefs of Edwin Chadwick, a pioneer in English sanitary reform; he held that all zymotic and other diseases were due to filth, and that clean living, improvement of water-supplies, refuse removal, and bettering the houses of the workers would bring about a reduction in the death-rate and the restriction or extinction of pestilences. These views ignored the knowledge gained by Sydenham and the epidemiologists of the eighteenth century on epidemic infection and morbid contagia. Bacteriology afterwards demonstrated that environmental hygiene, while of great value in preventing much morbidity and mortality, was not the whole explanation. The victim of the disease and the human carrier claimed attention as well as his surroundings. More recently, prevention has extended its sway into the study of sociology, eugenics, inheritance, race, nutrition and a hundred other subjects, embraced under the comprehensive term of 'social medicine', which disturb health and favour disease.

Tradition dies hard, and the instruction of medical students has not moved with the times. For many years it has properly been deemed desirable that instruction should be given in public health and preventive medicine in the medical courses of Great Britain and the United States. Yet too much attention is still devoted to details of sanitary engineering, drainage and sewage disposal. The student, with an overcrowded curriculum, is thus led to regard preventive medicine as a subject apart instead of one which should be closely integrated with his clinical studies of disease. It is satisfactory to know that a revision of undergraduate instruction in Great Britain is under consideration from this point of view.

Prof. Wilson G. Smillie's text-book has been written for medical practitioners and students to inculcate the sound doctrine that preventive medicine is an essential part of the practice of clinical medicine. It is a comprehensive treatise. The introduction gives a brief and lucid history of public health in the United States, including reference to the work of Lemuel Shattuck, a Boston bookseller, whose "Report of a General Plan for the Promotion of Public and Personal Health", published as a legislative document in 1850, became a foundation stone for public health and preventive medicine in the United States. Section VI of the book provides an admirable account of American public health administration which may be read with profit by all interested in this important aspect of social medicine. It is of interest to note that Paul Revere, immortalized in Longfellow's poem, was chairman of one of the first local boards of health, organised in Boston in 1798.

The whole field of preventive medicine is broadly surveyed, with emphasis upon the clinical aspect and the study of the individual. The material presented is based on clinical experience and illustrated by actual case-histories. Another good feature of the book is that the author gives references to articles in American medical journals, which enable the reader to extend his knowledge of special subjects. The book is not a system of preventive medicine, for the field covered is so wide that the author has had to compress his accounts of environmental hygiene, communicable and other diseases, child hygiene and adult diseases and their prevention into brief compass; and not all epidemiologists would agree with certain of his conclusions, for example, the statement made on p. 199 with reference to poliomyelitis that "there is little evidence that the patient himself is an important source of disease dissemination", a statement which seems to conflict with a footnote on the same page. The advanced student of preventive medicine must, therefore, supplement his studies by more extensive reading, but he could have no better introduction to the subject than Prof. Smillie's book.

ARTHUR MACNALTY

## METALS AND GASES

### Controlled Atmospheres for the Heat Treatment of Metals

By Ivor Jenkins. Pp. x+532+60 plates. (London: Chapman and Hall, Ltd., 1946.) 50*s*. net.

COMPLETENESS of the field covered, with authoritative discussion of both theoretical and practical aspects of the subject, make Mr. Jenkins' volume a book which will undoubtedly become a standard work of reference. It is particularly welcome, in that it possesses the additional merit of being written throughout in a concise and interesting manner. It is probable that in many cases the practical worker will not desire to study all the theoretical background of the technique which he is employing; but the arrangement of the material is such that the more practical aspects can be separately considered. At the same time the theoretical side is dealt with in a manner which will be of real interest and value to the more academic reader, and the author's intention of bridging the gap between the practical and academic aspects of the subject is successfully achieved.

The use of special atmospheres in the heat treatment of metals has assumed greatly increased importance in recent years, but the information has been scattered, and the wide range of applications dealt with in the present volume will probably surprise many readers. On one hand, there are the various atmospheres used to prevent oxidation, carburization or decarburization of steels during heat treatment, or to avoid oxidation or selective depletion of surface layers with non-ferrous materials. The composition of such atmospheres must often be designed as a compromise, balancing the conflicting tendencies of the various equilibria over the range of treatment conditions, and making the problem much less simple than might appear at first sight. On the other side are those conditions where composition and treatment are deliberately adjusted to obtain carburization or nitriding of steels, and in these cases, factors such as depth of case and concentration gradients may become of first importance.

The complexity of treatment which may be involved is well illustrated from the description of steel carburizing technique. Thus in certain cases the material may first be treated under slightly decarburizing conditions to activate the surface, and then subjected to carburizing treatment, involving the three stages of low-temperature sooting, carburization proper, and diffusion of the carbon to give the desired concentration gradient. Finally, the material must be heated for hardening in an atmosphere such that surface decarburization does not occur. These and the many other successful applications of controlled atmospheres are discussed theoretically and practically in some three hundred pages dealing with industrial applications, while earlier sections of the book deal in detail with the generation, purification and analysis of the various types of atmosphere employed.

While there may occasionally be some difference of opinion as to the precise value or interpretation to be put upon some of the published data quoted in the more theoretical sections, the careful survey of this material which the author has included throughout the book is a most valuable feature. In view of the detailed consideration given to carburizing and nitriding treatments, it would have been interesting to have had some reference to the role of gases in metallic cementation; but otherwise the ground covered is remarkably complete.

The usefulness of a book can be considerably affected by the clarity of its presentation. In the present case, author and publishers are to be congratulated, not only on the general arrangement and typography, but also on the wealth of excellent illustrations, which are a most valuable feature of the book.

C. S.

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## FOUNDATION OF THE JOHNS HOPKINS HOSPITAL

### The Johns Hopkins Hospital and the Johns Hopkins University School of Medicine

A Chronicle. Vol. 1. Early Years, 1867–1893. By Prof. Alan M. Chesney. Pp. xviii+318+37 plates. (Baltimore, Md.: Johns Hopkins Press; London: Oxford University Press, 1943.) 18*s*. 6*d*. net.

THE reputation of the Johns Hopkins Hospital was founded upon the inspired endeavours of a few great men, and in this volume Prof. A. M. Chesney gives the story which he has unearthed from documents in the archives in the Hospital and in the University. The result is a work which will be very acceptable to all who are interested in the history of medical education. There are many strong ties between the Johns Hopkins and Great Britain—probably the greatest of which was its gift to us of William Osler, who left the Johns Hopkins in 1905 to take the regius chair at Oxford.

The year 1867 marks the foundation of both the University and the Medical School, since in that year Johns Hopkins caused to be introduced into the General Assembly of Maryland bills authorizing the formation of two corporations to found and administer these separate—though closely connected—institutions. His choice of trustees stamped Johns Hopkins as a man of great discrimination, as his scheme had shown him to be a man of wide vision. The University opened its doors in September 1876 with a "Faculty of Philosophy" consisting of six professors and their assistants. Huxley delivered the address at the opening ceremony. Almost straight away, under the direction of its enlightened president, Daniel C. Gilman, the University introduced courses in the basic sciences required by medical students. There were many unavoidable delays in the building of the Hospital, and it did not open its doors for patients until May 1889. The four luminaries who had been induced to take up the leading professional posts are portrayed in Sargent's well-known picture—William Osler (medicine), W. S. Halsted (surgery), Howard A. Kelly (gynæcology), and Welliam H. Welch (pathology). The rapidity with which these four men built up a distinguished reputation for the Hospital is well known.

Prof. Chesney's careful work gives much about the lives of these four men, but it will be valued even more for the brief lives of other giants who are less well known in Great Britain—W. S. Thayer, J. M. T. Finney, J. J. Abel, Franklin Mall, W. H. Howell, and many others. As a guide to the difficulties which beset the foundation of a new institution the work will naturally have great value. We look forward to the appearance of the remainder of this history.

E. Ashworth Underwood

# AN ELECTRICAL HYPOTHESIS OF CENTRAL INHIBITION

By C. McC. BROOKS*
AND
PROF. J. C. ECCLES, F.R.S.
Physiology Department, University of Otago, New Zealand

AN electrical hypothesis of synaptic transmission has recently been proposed[1,2] which was based upon generally accepted data pertaining to the structural features of the synapse and to the electrical and excitatory properties of nerve and muscle. This hypothesis offered the first precise explanation of the temporal course of the excitatory events occurring during synaptic transmission. However, it gave no explanation of inhibition, which is so fundamental a counterpart of excitation in the functioning of the central nervous system. The hypothesis here formulated as an extension of the excitatory hypothesis rectifies that deficiency, and is likewise able to offer the first precise explanation of the temporal course of inhibition in terms of generally accepted structural and functional properties of neurones and of the synaptic contacts between them.

The development of such a hypothesis is the more necessary because the following carefully designed experiments have recently shown that inhibition of spinal reflexes occurs under conditions that preclude its explanation by all the theories hitherto elaborated[3,4]. The myotatic (stretch) reflex involves a single synaptic relay in the spinal cord with a synaptic delay of about 0·7–1·0 msec.[5–10] that is, centripetal impulses from a muscle entering via the dorsal roots pass directly via the reflexo-motor collaterals[11] to synapses on the motoneurones of that muscle. Inhibition of such a direct reflex pathway is produced by impulses from antagonistic muscles entering the spinal cord slightly before (0·2 msec.) or even simultaneously with the excitatory volley, that is, the central inhibitory time is no more than 1·0–1·1 msec.[3,6,12–15]. This inhibition is observed even when the respective excitatory and inhibitory pathways converge on the motoneurones from diametrically opposite directions[12]. Two arguments have been derived from this evidence. (i) The inhibition is exerted *directly* on a two-neurone arc and cannot be explained by any theory[16–20] that involves refractoriness or subnormality of interneurones or some failure of summation due to temporal discrepancy in synaptic bombardment. Furthermore, it must occur within the confines of the motor nucleus and hence be exerted either in the presynaptic terminals[14] or on the motoneurones themselves[3]. (ii) The short central inhibitory time shows that the inhibitory impulses act with no more synaptic delay than the excitatory impulses; hence it is argued that there are likewise no interneurones in the inhibitory pathway. However, it will be shown below that this latter inference is not valid.

Thus there has been a return[3] to the original concept of Sherrington[21–23], that there are converging on motoneurones two sets of impulses: those exciting and so tending to cause the reflex discharge of impulses, and those directly opposing this influence. In regard to the mechanism of this inhibitory action, there has been no theoretical advance beyond three vague suggestions: (1) that the inhibitory impulses block the excitatory impulses in the presynaptic terminals[14], presumably by some anelectrotonic action[24,25]; (2) that the inhibitory effect is exerted on the motoneurones because the inhibitory impulses terminate in some special spatial pattern on the motoneurone, for example, around the axon hillock[12,26–28]; (3) that there are specific inhibitory synapses at which presynaptic impulses exert an effect which is the functional opposite of excitation[2,12].

None of these is satisfactory. Renshaw's[14] experimental support of the first is susceptible of alternative explanation[29], and, as Lloyd[3] points out, it is difficult to conceive of impulses affecting the terminals of fibres in a motor nucleus without at the same time acting on the motoneurones. Actually such a secondary block is directly demonstrable, but only as a secondary phenomenon some milliseconds after the onset of inhibition[29]. In mammalian motoneurones there has been no demonstration[30] of any specific spatial distribution of presynaptic terminals such as occurs with Mauthner's cell[27]. Nor has there been any histological evidence of two distinct types of synapse[27,30] such as would be expected on the third suggestion. In this connexion there has been, of course, an attempt to explain inhibition as due to the liberation of an inhibitory substance antagonistic to an excitatory transmitting substance, but no evidence supports such a contention, and it now seems probable that the peripheral excitatory transmitter, acetylcholine, plays no part whatsoever in central synaptic transmission[31].

None of the above objections can be offered against the hypothesis developed here from the following assumptions, which are based on well-established properties of neurones and their synapses.

(*A*) The synaptic knobs closely investing the surfaces of the soma and dendrites of a motoneurone (and indeed of any neurone in the central nervous system) may be divided into two types which are intermingled on the surface: (i) those belonging to the long axons of neurones, including the dorsal root fibres (the reflexo-motor collaterals of Cajal); and (ii) those belonging to axons no more than 2–3 mm. in length. Following Cajal[11], the neurones with short axons will be called Golgi cells. They are now known to be numerous in the spinal cord as well as in the brain, and to be interpolated (hence the alternative names, internuncial neurone and interneurone, which, however, need not necessarily have such short axons) in most pathways between entering dorsal root fibres and motoneurones[19,32].

(*B*) The surface membrane of the soma and dendrites of a neurone has essentially the same electrical properties as the axon—see assumption *B* of the excitatory hypothesis[1,2]. For example, the soma is electrically excitable[5,33,34], and impulse propagation occurs over its surface presumably just as with the axon[34–37]. Its excitability is raised by catelectrotonus (outflowing currents) and decreased by anelectrotonus (inflowing currents)[25]. In addition, assumption *C* of the excitatory hypothesis[1,2] postulates a specialization of the immediate post-synaptic areas of the soma (and dendritic) membrane whereby they react to synaptic excitation by local responses[38] rather than by the all-or-nothing membrane breakdown characteristic of the propagated impulse. It is possible that the minute size of such post-synaptic areas is alone responsible for this specialized reaction.

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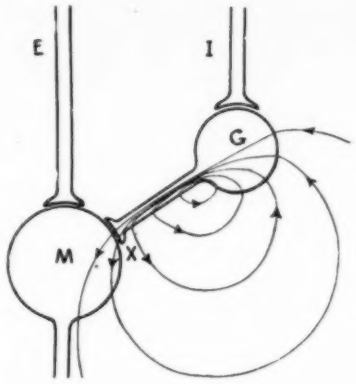


Fig. 1

(*C*) When a presynaptic impulse is propagated down to a synaptic knob on the surface of a neurone, it sets up a local response of the immediately adjacent post-synaptic membrane[1,2], which consequently is depolarized by diminution of its E.M.F. and resistance. Current flows from other areas of the neurone's surface (soma, dendrites and adjacent segments of the axon) into this relatively negative focus, thus producing the synaptic potential as recorded either by an adjacent focal (needle) electrode[34] or from the ventral roots[10,25,39]. If the synaptic potential is sufficiently large (that is, if a sufficient number of synapses is excited), the surface membrane of the neurone will be sufficiently depolarized, both intensively and extensively, to initiate the discharge of an impulse. If it is not, then after perhaps some spread of the active foci[34], the excitation dies out and the rebuilding of membrane potential gives the characteristic exponential decay of the synaptic potential.

These assumptions will now be applied in operating a schematic model (Fig. 1) of the simplest situation in which inhibition occurs. It has been shown by Lloyd[3] that the afferent fibres from a muscle excite the motoneurones of that muscle and its synergists and inhibit the motoneurones of its antagonists. The excitatory path is monosynaptic, and he has assumed from the similarity between the central excitatory and inhibitory times (each about 1 msec.) that this is also true for the inhibitory path. However, it will be shown that such similar timing is to be expected if a Golgi cell, *G*, is interpolated on the inhibitory pathway. Thus we have the excitatory reflexo-motor collateral, *E*, ending in a synaptic knob directly applied to the motoneurone, *M*, while the synaptic knob of the inhibitory fibre *I* (also a collateral of a dorsal root fibre) ends on *G*, which in turn has its knob on *M*. Many such knobs as those shown may be imagined covering the somas and proximal dendritic regions of *G* and *M* (assumption *A*).

If a volley of impulses which is being propagated to synaptic knobs of *I* fibres sets up a synaptic potential (assumption *C*) which is too weak to initiate the discharge of an impulse from *G*, current will flow as shown in the diagram during the whole temporal course of this potential; hence the axon (and inactive areas of the soma and dendrites) will act as a source for the current flowing in through the sink of the active areas. The size of the synaptic potential recorded from an emerging ventral root has shown that the axon acts as a considerable source of current even two or more millimetres from the soma[10,25,39]. With *G*, therefore, there will be, as shown, a considerable outflowing current from the synaptic knob of its axon, where the expanded area (due to branching as well as the swelling) of the highly resistant surface membrane gives favourable opportunity for current penetration. On account of the close synaptic apposition, this outflowing current will in large part penetrate the post-synaptic membrane of *M* (Fig. 1) and produce there a localized region of anelectrotonus, which will be a region of depressed excitability (assumption *B*). Of course, this penetrating current will also have to pass outwards across the surface membrane of *M*, leaving there a cathodal (excitatory) action, but such effects will be negligible in intensity because so widespread over the neurone and so much in the unstrategic areas of the dendrites. It is even possible that the *raison d'être* for the widespread dendritic branching is to provide the soma with a widely distributed surface for a dispersed return circuit through the grey matter.

Consider now the situation arising when impulses are fired simultaneously along several *E* and *I* fibres. The *E* impulses will produce local responses in the regions of *M* beneath their synaptic knobs, and, if of sufficient intensity, these responses will rapidly fuse and spread, generating the discharge of an all-or-nothing impulse (assumption *C*).

However, the *I* impulses are simultaneously producing local responses in *G* cells and so simultaneously causing anelectrotonic foci under the synaptic knobs which these *G* cells have on *M*. Thus the simultaneous *E* and *I* volleys give rise simultaneously to a mosaic of patches of local response and of anelectrotonus on *M*. The anelectrotonus suffers from the disadvantage that its rising phase will be somewhat delayed on account of its electrotonic spread from the soma of *G*, but the local responses on *M* also take a little time (usually 0·2–0·5 msec.[10]) to spread and fuse sufficiently to initiate the impulse discharge. Hence the anelectrotonic areas on *M* should just be able to exercise an appreciable depression on the spread of the local responses when the *E* and *I* volleys are simultaneous; and there should be a rapid increase in the depression as *I* is moved earlier relative to *E*, for then, as the local responses are being set up under *E* knobs, they will be presented with a well-established anelectrotonic mosaic.

According to the excitatory hypothesis[1,2], the synaptic potential generated in cell *M* by impulses in one set of *E* fibres is the cause of the facilitation of *M*'s reflex discharge in response to impulses in another set of *E* fibres[3,10]. Likewise the present inhibitory hypothesis attributes the inhibition of such a reflex discharge to the synaptic potential which impulses in *I* fibres generate in *G* cells. Hence the time courses of such facilitation and inhibition should be relatable to the synaptic potential and so to one another. This prediction receives striking confirmation from the recent determination of the time courses of the unitary excitatory[3,10] and inhibitory processes[3] set up by *single* *E* and *I* volleys uncomplicated by impulses relayed through interneurones (*E* and *I* curves of Fig. 2). It is evident that the respective hypotheses would predict the similar decaying phases observed for the two curves, for it relates both to the decay of the synaptic potential[10,34]. The differences in the early phases are also predictable. Simultaneous action of the two excitatory volleys would

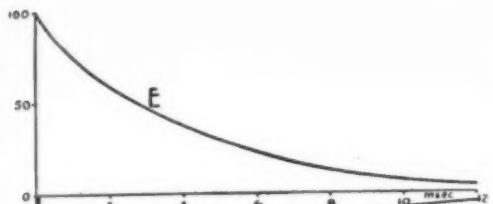


Fig. 2

give optimum conditions for summation of synaptic potentials, and hence the facilitation curve, *E*, would be expected to decay from a maximum with zero interval between the two *E* volleys[9,10]. On the other hand, we have seen that the inhibitory hypothesis predicts that the inhibitory curve, *I*, should rapidly increase from zero inhibition at about zero *I E* interval. Focal recording shows that the synaptic potential of the soma of the neurone (as distinct from that picked up from the ventral root[10]) takes about 1·0–1·5 msec. to attain its maximum[34], but the *I E* interval for optimum inhibition would be expected to be shorter than this, for the optimum would occur as soon as the developing anelectrotonic foci in *M* had an adequate start over the developing local responses of *M*. At an *I E* interval of 1–1·5 msec. the anelectrotonic foci would be fully developed when the local responses of *M* were being initiated, and would actually be decaying during the growth of these local responses; hence such an interval would be well beyond the optimum. The inhibitory hypothesis would thus predict the unitary inhibitory curve actually observed (*I* of Fig. 2) rising from zero to a maximum at about 0·5 msec. and then decaying with much the same time course as the unitary facilitation curve (*E*).

Hitherto it has been assumed that the *I* volley does not generate in *G* sufficient synaptic potential to evoke the discharge of an impulse. If this had occurred, the hypothesis would predict that the usual synaptic excitatory action would have ensued upon the arrival of the impulse at the synaptic knobs on *M*. Thus there would be an initial period of inhibition passing over to excitation about 1·0–1·5 msec. later. The additional delay would be largely spent in initiating the impulse in *G*, and in the synaptic delay involved in setting up local response under the knobs on *M* (cf. the excitatory hypothesis[1,2]). Lloyd (ref. 3, Figs. 8 and 10; ref. 4, Fig. 3) has observed precisely this transition after about 1·5 msec. from a primary inhibition to a secondary facilitation, and furthermore he finds it impossible to distinguish by threshold the afferent fibres responsible for these two effects. The slightest increase in the strength of the stimulus to the afferent nerve suffices to superimpose a secondary facilitation on a pure primary inhibition. In terms of the hypothesis, a slight increase in the *I* volley causes many *G* cells to discharge impulses, so generating the secondary facilitation of *M*. Thus the principle emerges that the synaptic knobs of a Golgi cell's axon have a pure inhibitory action or a diphasic inhibitory-excitatory action according as the synaptic potential of that cell is not, or is, adequate to evoke the discharge of an impulse.

On the other hand, at the synaptic knobs of axons more than a few millimetres in length such a situation would not arise, because no appreciable current would be generated there by synaptic potentials of the somas; and this would also obtain *a fortiori* for the dorsal root fibres, where the somas generate no synaptic potential. All such synaptic knobs would be purely excitatory. However, short collaterals arising from long axons close to the soma (the axon collaterals) would resemble the axons of *G* cells in being potential inhibitors. Hence arises a reason for the fact that the fibres of the long tracts in the spinal cord, for example, the pyramidal tract, end in synaptic relationship with Golgi cells and not directly with motoneurones[13,40,41]; for by so doing they become potential inhibitors as well as excitors of the motoneurones.

Reference to Fig. 1 reveals that according to the inhibitory hypothesis a needle electrode (insulated to the tip) close to the synaptic knobs of the *G* cells on the motoneurones, for example at *X*, would be expected to show a positive potential (relative to an indifferent electrode) having approximately the same time course as the inhibition. Positive focal potentials are indeed recorded from regions of inhibited motoneurones[14,39], but their time courses do not as a rule correspond with the inhibitory curves. In accordance with the hypothesis, blocking internuncial pathways by very deep anæsthesia shortens these positive focal potentials, so that their time course is similar to that of the negative synaptic potential[39]. However, under conditions giving unitary inhibition (hamstring afferents inhibiting quadriceps motoneurones), the focal potential may be negligible or show a very small positivity or negativity[39]. In evaluating such observations, it must be realized that, since the Golgi cells are interspersed between the motoneurones[13,32,41], their synaptic potentials may be recorded either as negativity or as positivity; for example, *X* in Fig. 1 might also be close to the somas of other *G* cells, recording their synaptic potentials as a negativity. Therefore the negligible focal potential set up by a hamstring afferent volley in quadriceps nucleus would be expected if its inhibitory action were due to the synaptic potentials that it set up in Golgi cells within that nucleus. Thus in testing the inhibitory hypothesis it will be necessary to study the spatial distribution as well as the time course of the focal potentials set up by inhibitory volleys.

The association of inhibition with a positive cord potential (recorded with leads on the surface of the spinal cord), and hence with anelectrotonus, has been widely recognized[16–18,20,42]; but in formulating theories of inhibition it has always been assumed that such potentials were homologous with the positive after-potentials of peripheral nerve, and hence always subsequent to the discharge of an impulse by a motoneurone or an interneurone. This is certainly not the case with direct inhibition, which is now known to play such an important part[3,4] that other mechanisms appear of but secondary importance. The production of anelectrotonus by the mechanism illustrated in Fig. 1 is the first attempt to give a coherent account of the mechanism of this direct inhibition[3].

An argument against the present anelectrotonic hypothesis of inhibition is that during inhibition of motoneurones no positivity is detectable by ventral root recording[25], that is, on the axon of *M*, which on the contrary shows a large negative potential during the subliminal excitation of motoneurones[10,26,39]. However, the situations are not comparable, for with excitation the current will be flowing into the activated areas from other areas, including the proximal regions of the axon; whereas with inhibition the current generating the anelectrotonus will be flowing inward under the synaptic knobs and outward at other areas (Fig. 1). Thus the current flow in the ventral root will be just the same as with excitation, and hence during inhibition the ventral root potential should be in the same direction as with excitation despite the diametrically opposite effect on the soma. However, since it is generated extrinsically to the motoneurone, it would be much smaller than the synaptic potential.

The large 'stretch' afferents of a muscle excite that muscle and its synergists by a monosynaptic pathway and 'directly' inhibit its antagonists[3,4]. According to the inhibitory hypothesis, Fig. 3 gives the pathway for this reciprocal relationship between the flexors and extensors of a joint (the knee; *Q* quadriceps; *H* hamstrings) which we may regard as the simplest co-ordinative act of the central nervous system (cf. the classical figure of Sherrington[42]). The flexor and extensor 'reflexo-motor' collaterals end at synaptic knobs on the respective flexor and extensor motoneurones (*M*) and also give off collaterals[11] to Golgi cells (*G*), the synaptic knobs of which are reciprocally distributed to the extensor and flexor motoneurones respectively. Fig. 1 gives the key to the operation of Fig. 3 as a model of reciprocal innervation.

These illustrations suffice to show that the present hypothesis offers a precise and simple explanation of some inhibitory phenomena. Its performance is just as impressive in relationship to all other experimental observations that we have found in the literature. In particular, it should be noted that according to the hypothesis, inhibition is not a threshold phenomenon. All gradations of intensity can exist in the respective anelectrotonic and catelectrotonic areas of the mosaic on a soma, and the initiation of an impulse virtually will be dependent on their algebraic summation, much as was postulated for the excitatory and inhibitory states, C.E.S. and C.I.S.[21-23]. Thus the excitatory and inhibitory hypotheses may be regarded as developments from these original concepts, which so adequately fitted the literature up to that time.

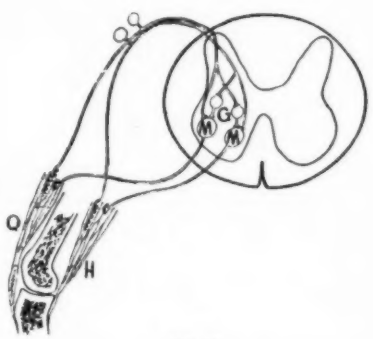


Fig. 3

The concept of the subliminal fringe has been fruitful in its application to reflex phenomena[23,44,45], but the present hypothesis gives new potentiality to it. Hitherto it has regarded the subliminally excited neurones (the subliminal fringe) as a transitional group available for facilitation. Now we postulate that the Golgi cells of the subliminal fringe are, in addition, acting as inhibitors of the neurones next in series. Thus with the exception of the monosynaptic reflexes, an inhibitory surround will encircle the active focus of a reflex; hence arises a ready explanation of simultaneous contrast, which is of such importance in the neural mechanisms of conditioned reflexes and of vision. In this latter connexion it is further to be noted that an inhibitory action of the retina is associated with a prolonged potential of opposite sign to the excitatory potential[46], and that there are many neurones of the Golgi cell types in the retina, for example, the bipolar and amacrine cells. The inhibitory function of the subliminal fringe may also provide the basis for an explanation of rhythmic reflexes, which hitherto have been so poorly understood[23].

The most interesting feature of the present inhibitory hypothesis is the dual role it gives to the Golgi cells. Undoubtedly these cells often act as excitatory links in reflex pathways which may eventually exert excitatory or inhibitory actions on motoneurones. Hence arises the familiar 'delay path' explanation of prolonged excitatory or inhibitory action[19,23,35]. Others may normally never be sufficiently excited to discharge impulses, and hence always function as inhibitors. But some would appear to function as inhibitors or excitors according to the degree of their own excitation; and, of course, any such Golgi cell in a chain would be able to act as an inhibitor of the Golgi cells next in series. Now Golgi cells arranged in the most intricate cross-linked chains form the outstanding feature of the structure of the higher centres of the brain[22,47]; hence the hypothesis that such cells are responsible for inhibition and may be either excitatory or inhibitory according to circumstances leads to the most interesting speculations. For example, in normal cerebral activity there is believed to be continual rhythmic discharges of cells with impulses circulating around neurone chains of unimaginable complexity. According to the hypothesis, we must assume in the normal waking state a delicate poise of Golgi cell activity giving a balance of excitatory and inhibitory action. If now any depression of cortical activity is brought about, the lowered excitation in the Golgi cells would cause the reversal of many from excitors to inhibitors, and hence deepen the depression; and conversely, raised excitation would convert inhibitors to excitors. Such reactions would seem to provide a clue to the understanding not only of the subtlety of reactions of the cerebral cortex, but also of its very great sensitivity both to narcotics and to convulsants. For example, narcotics not only would depress the excitation, but would thereby augment the inhibition. Likewise lowered cortical activity due to deprivation of most incoming sensory impulses would convert excitatory Golgi cells to inhibitors, so bringing about the widespread cortical inhibition that we know as sleep. Of course, a continued inhibition would be dependent on some continued cortical activity; hence active inhibition in the early stages of sleep would be expected to give place to mere inactivity. This parallels the observation that sleep lightens an hour or so after its onset[48]. Such examples illustrate

how the hypothesis may be of value in understanding the functioning of the higher parts of the central nervous system.


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## THE ROYAL ACADEMY, 1947

By Dr. A. TINDELL HOPWOOD

THERE are those who exhibit at the Royal Academy, and those who do not: there are those who visit the Royal Academy, and those who do not. Once the doors of the Summer Exhibition are opened, those who do either are of present importance and mutually dependent. The interplay of artist and visitor makes each new show a fresh adventure for anyone who is neither too ignorant to have acquired that sense nor so bored as to have lost it. Ignorant may seem a harsh word to use, but it is not unkindly meant. One cannot find intellectual adventure in that which one does not understand, but there is adventure in the effort necessary to understanding. For most people the annual adventure of the Academy consists in making the effort to understand. None but a favoured few can hope to escape the necessity of effort, since there are very few who can easily understand what an artist is striving to achieve. According to Michelangelo, "Good painting is a music and a melody which only the intellect can appreciate, and that with great difficulty". The same sentiment has been repeated by successive generations of artists, among others by the Academy's first president. This, if it be true—and there can be no argument about that—makes nonsense of the claim that 'art belongs to the people' taken in its usual connotation. On the other hand, it is true that art belongs to so many of the people as are willing to make the intellectual effort necessary for its comprehension. In art, as in all other human activities, one cannot have something for nothing.

Out of nothing, nothing is made, is just as true of artists as of spectators. The latter reveal the vacant mind by their chatter, the former reveal it in their works. Every year such minds are with us, but the Hanging Committee can usually find spots where their patients may linger in comparative obscurity. Perhaps it is unfair to introduce in this way an exhibition which is so much better than its predecessor, but I do not think it is. The higher the general standard, the more obvious do the babblers become; but it is also easier to close one's ears to their babble.

For the past fifty years there has been much noisy argument about the modern movement in art, and the modernists have shown a degree of intolerance equalled only by the intolerance of their opponents. The point at issue really boils down to whether line or colour is pre-eminent. The question is of small significance because each artist and each spectator will return that answer which best accords with his own temperament. There is no merit in denying the artistic worth of "Bol de Lait" by the late Pierre Bonnard, neither is there merit in praising it to the detriment of more academic canvases. Bonnard was a colourist and light was necessarily his primary interest. Now it is a curious thing that light, which reveals to us the planes and perspectives and all the geometry of Nature, ends by obscuring what it reveals. Turner knew this in his day, and M. Bonnard's picture is a restatement in a different idiom.

It is fitting that works by a great Frenchman should hang in the Academy, for it is from France that the moderns draw their inspiration; but one should not forget that the French themselves derive from an Englishman, John Constable, whose strivings after light were no less intense than those of Cézanne. Moreover, the inspiration from across the Channel must not blind us to the native interpretation of Constable's teaching. For this reason attention should be given to Sir Alfred Munnings' "Frisian Bull", in which the landscape suggests that his oft-expressed affection for George Stubbs is equalled by his affection for Constable. "Sketch of a Newmarket Start", which hangs a few feet from the bull, is full of a nervous vitality vastly different from the bucolic peace of the latter, and this tends to obscure the masterly skill with which the rhythmic motion of the jockeys and their mounts is conveyed.

One of the less good positions is No. 1. It is on a reverse wall, but has the compensation that most visitors look there when they are fresh, and before their energies have begun to flag. Here hangs "Once Upon a Time" by Lilian Jelly, noteworthy for its interpretation of texture and line. On the same wall,

"Autumn", by Dame Laura Knight, is the first of three valiant and not unsuccessful attempts at rendering atmospheric effects of great difficulty.

The same room contains several pictures by younger artists, two of whom appear for the first time: "A Yellow Dressing Table" is by Pat Newton, and "Still Life" by Henry Kilvert. There are also three flower pieces, "Autumn Flowers", by Elsie Atkins, who exhibited in 1944 and 1946; "Summer Flowers", by Vera Waddington, also an exhibitor in 1944 and 1946; and "Geraniums", by D. Travers-Smith, whose picture last year was, I think, her first. Both Miss Atkins and Miss Waddington paint flowers well, and each has shown in previous years that she is not afraid of other subjects. The arrangement of Miss Travers-Smith's geranium is rather obvious, and the design is over-emphasized by the background. Best of all is the yellow dressing-table in its garret window; there is more originality in the subject, and more character in the painting.

One of Mr. Churchill's pictures hangs near the dressing-table. It is "Winter Sunshine", a not altogether successful sketch of a red-brick house standing in a snowy garden. The arrangement of the high lights, and the mass of shadow in the middle of the canvas, give the impression that the centre of the picture has dropped out. His other picture, said to be a later work, is in Gallery III. "The Loup River, Alpes Maritimes" is above the average in its rendering of flowing water. Taken together, they show Mr. Churchill to have considerable talent as a painter, but they display none of that robustiousness popularly associated with Mr. Churchill the politician.

If the Academy were restricted to oils, one might well stop there, for what has been said serves as a sample of the whole. As it is, there are other media to consider, and of them the water-colours in the South Rooms are easily the most important. Water-colour drawing is so essentially an English art that one is not surprised when its practitioners prove to be more consistently interesting than the painters in oils. R. Vivian Pitchforth, Barbara Jones, Hadley Rowe and Peter Lowry each has something worth saying, though Mr. Rowe should know better than to put tropical shells on what appears to be a typically English beach. Mr. Pitchforth is, of course, one of our leading water-colourists and an associate of the Academy, but Miss Jones and Mr. Rowe are, I believe, exhibiting for the first time. There is both character and individuality in their work. Mr. Lowry had pictures hung in 1945 and again last year; that he tends to dramatize his subject is not necessarily a fault. Two pictures of the shipyards at Appledore possess a maturity and sureness of touch which prove Michael Leszczyński to be much more than a beginner, even though this is the first time he has been hung in the Academy. Hal Yates' "Runswick" and Dennis James' "Snow Scene, Kingsley Way" each deserve more than a passing glance; the latter is not hung as well as it should be.

To return to the oil-paintings. Henry Hoyland has been represented by a picture or two since 1944, and, as his two studies of the circus show, he improves each year. Jean Primrose has two works of great promise in "Ballerina" and "Angela Reading", and that brings us to the Black and White Room (Gallery IX). This I found dull apart from Miss Winifred Austen's bird studies, which have a charm all their own, and Robert Austin's engravings. Sir Lionel Lindsay's dry-point is of particular interest: it throws a flood of light on his book "Addled Art".

There is little to be said about the architectural exhibits; present conditions are not kind, and architects are in partial eclipse. Neither is the sculpture very interesting. It is always difficult to make a gallery of small busts look anything but spotty, and this year the difficulties appear to have proved greater than usual.

Nevertheless, this is a 'good' Academy, and if the next can improve on it as much as this one has improved on last year's, then there will be firm reason for thinking that artists as a whole have recovered from their post-war malaise.

## THE ADRENAL CORTEX

THE fourth meeting of the Society of Endocrinology, held on March 28 in the Department of Anatomy, University of Birmingham, was devoted to a discussion on the adrenal cortex. In the opening paper, entitled "Recent Advances in the Chemistry of the Adrenal Cortex", Dr. C. W. Shoppee mentioned briefly the six steroids newly isolated from adrenal tissue during the past seven years, which include œstrone, $\Delta^4$-androstene-3 : 17 dione, and 17-hydroxyprogesterone. The total number of adrenal steroids with known structures is now twenty-eight, of which six are active in preserving the life of the adrenalectomized animal. The structures of most of these compounds are completely determined. Where hydroxyl groups exist at positions 3 and 11 they are (β) orientated, while hydroxyl groups at position 17 are almost certainly in the (α) position. During the past few years it has become clear that adrenal steroids, as well as deoxycholic acid, have the side-chain at position 17 in the (β) position and not, as was previously believed, (α) orientated. Reichstein has now prepared all six physiologically active steroids artificially. The molecular features essential for high activity appear to be a 3-keto-$\Delta^4$-grouping, together with a 17 (β) side-chain of the form $-CO.CH_2OH$. For activity with respect to carbohydrate and protein metabolism, an oxygen atom at $C_{11}$, either as a keto-group or a (β)-orientated hydroxyl group, appears to be essential.

The pure crystalline substances isolated from cortical extracts represent only a small fraction of the activity of the concentrates from which they are prepared: the greater part of the activity (about 90 per cent) remains in the so-called amorphous fraction. The latter shows somewhat anomalous physiological properties, and it is likely that there remain to be isolated one or more unknown labile compounds, probably containing five oxygen atoms, which are more active than any of the hormones yet obtained in a state of purity. Lowenstein and Zwemer (*Endocrinology*, **39**, 63; 1946) have recently reported the isolation of 11-dehydrocorticosterone and two incompletely characterized substances, the combined activity of which equalled 80 per cent of the activity of the original concentrate. One of these compounds gave ascorbic acid by mild anaerobic hydrolysis; the other, presumably steroid, product of hydrolysis has not been isolated.

In his communication entitled "The Pituitary–Adrenal Relationship", Dr. M. Reiss discussed first the problem of the isolation and biological assay of pituitary corticotrophic fractions. For assay purposes, Dr. Reiss and his colleagues have investigated the histological changes occurring in the adrenal glands of hypophysectomized rats. The sudanophilic

substances between the zona glomerulosa and the zona fasciculata were found to disappear seven to ten days after hypophysectomy, the wide so-called sudanophobic zone thus formed being an enlargement of a very thin zone normally present in young rats. This zone is abolished by treatment of the hypophysectomized rat with corticotrophic extract, and a standardization of the extract is based on these histological changes. Workers in two different laboratories (those of H. M. Evans and of C. N. H. Long) have isolated, by different procedures, the same pure substance which they claim to be the corticotrophic hormone. This does not exclude the possible existence of more than one corticotrophic substance; and indeed when one considers the multitude of active substances produced by the adrenal cortex, the existence of different corticotrophic substances responsible for the mobilization of these adrenal steroids is by no means impossible. The influence of the known corticotrophic substance on the adrenal cortex is complex. The cholesterol content falls in the first three hours (rat) and later rises. A fall of ascorbic acid content is detectable an hour after corticotrophic treatment, and the fall is proportional to the dose given. By direct estimation the hormone content of the adrenal gland was found to be increased 24 hr. after treatment, but substantially reduced 48 hr. after (Hempill and Reiss, unpublished). The changes in the hormone activity of the blood were opposite to those of the adrenal tissue.

Although adrenal function is considerably diminished after hypophysectomy, there is no reason to believe that adrenal-cortical activity ceases in the absence of pituitary corticotrophin; the hypophysectomized rat can survive the avulsion a year or more, but it would die in the course of a few days if all the cortical tissue had been removed. Little is known about the nervous control of the pituitary anterior lobe production of corticotrophin, though it appears probable that the secretion of corticotrophin is influenced by a psychic factor. Although the physiological effects of corticotrophin are mainly to be ascribed to stimulation of the secretory activity of the adrenal cortex, it would not be surprising if some actions of corticotrophic extracts failed to agree with those of known adrenal steroids. It is probable that adrenal steroids remain to be isolated, while it is yet uncertain if all those isolated are of physiological significance.

In his survey of the "Adrenal Cortex and Metabolism (including Electrolyte Metabolism)", Prof. F. G. Young pointed out that at present no simple comprehensive theory seems able to explain the diverse actions of adrenal steroids, and as more experimental evidence becomes available the earlier generalizations seem less and less certain. It is important not to neglect the fact that when one injected a hormone one was studying not merely the effect of the hormone on the animal but also the interaction of the animal and the hormone. Changes in food intake, adaptation to newly imposed experimental procedures particularly in long-term procedures, metabolic interconversions of administered steroid substances, all could and probably do complicate the interpretation of apparently simple experiments. In particular, the control of food intake by paired-feeding control experiments is of the greatest importance. Conway and Hingerty (*Biochem. J.*, **40**, 561; 1946) have shown that the potassium ion content of the muscles of the adrenalectomized rat is raised. This controverts the idea that the increased blood potassium is to be ascribed to leakage of potassium ions from the tissue cells. These authors have also shown a striking increase in plasma and muscle magnesium ion content, possibly significant to the muscular asthenia of adrenal insufficiency. The influences of adrenalectomy on carbohydrate and protein metabolism can be largely prevented by adequate therapy with sodium chloride, although such treatment does not prevent the catastrophic fall in carbohydrate storage which results from a short period of starvation in the adrenalectomized rat. Since deoxycorticosterone and the amorphous fraction of adrenal extracts both possess striking activity in inducing retention of sodium chloride in the normal and adrenalectomized animal, it is perhaps surprising that these adrenal fractions have so little action on carbohydrate and protein metabolism. Moreover, an important *in vitro* action of adrenal extract on hexokinase activity has been traced to the amorphous fraction.

Cori *et al.* (*J. Biol. Chem.*, **160**, 633; 1945: *Fed. Proc.*, **5**, 150; 1946) have shown that the activity of hexokinase in catalysing the transfer of a phosphate group from adenosinetriphosphate to glucose, forming glucose-6-phosphate, is diminished *in vitro* by the addition of anterior pituitary extract, and that this pituitary inhibition can be emphasized and extended by the addition of adrenal extract, though the latter alone has no obvious action in this respect. The influence *in vivo* of adrenal extract on other enzyme systems (for example, arginase, phosphatase, cytochrome oxidase) has opened up new lines of investigation of the greatest significance. It seems possible that the adrenal hormones, like enzymes, are not essential for the mechanisms of the body, but hasten or retard reactions which will proceed in the absence of the hormones.

In discussing "The Adrenal Cortex in Shock and Stress", Dr. G. Ungar pointed out that there is good experimental evidence for three main conclusions: (1) adrenalectomized animals exhibit a lowered resistance to many different types of noxious stimuli; (2) the adrenal glands show morphological changes after exposure to these stimuli; (3) the administration of adrenal steroids can, in some instances, enhance the resistance of adrenalectomized animals to these stimuli. It has long been known that stimuli can sometimes induce in animals a temporary increase in resistance to the same and non-related stimuli. Selye has proposed the term 'adaptation syndrome' in this connexion, and divides this syndrome into three stages: the alarm reaction, the adaptation phase, and the exhaustion phase. Most of the symptoms of the adaptation phase cannot be induced in adrenalectomized animals, though the secretory activity of the adrenal cortex is not the only factor concerned. The influence of adrenal steroids on carbohydrate and protein metabolism, and on the involution of the thymus and lymphatic tissue generally, are of importance, but, as Dr. Ungar himself has shown, the spleen is also concerned. Noxious stimuli cause shortening of bleeding time, increase in capillary resistance, and reduction of capillary permeability. All these effects are prevented by hypophysectomy, or adrenalectomy, or splenectomy, and can be reproduced in appropriate circumstances by corticotrophin, whole adrenal extract and suitable spleen extract.

A substance which can account quantitatively for the action of cortical extracts is a recently isolated

adrenal steroid, $\Delta^4$-pregnene-3-one-17(β) : 20β : 21-triol. The active splenic substance has been obtained in very pure form, and its chemical identification is being carried out by Prof. E. L. Hirst in Manchester. During adaptation there is a reduction in the amount of histamine that can be liberated from blood cells. Histamine is liberated through the action of a proteolytic enzyme normally held in check by an inhibitor; in certain pathological conditions the enzyme is set free and is then able to split off histamine from some protein substrate. It is possible that the adrenal cortex can inhibit the liberation of the proteolytic enzyme.

In her consideration of the rate of secretion of the mammalian suprarenal cortex, Dr. Marthe Vogt first discussed the different methods available for the biological assay of adrenal cortical hormones. Most of the information on the amounts of cortical hormones present in body fluids has been obtained with methods involving the deposition of glycogen in the livers of fasting normal rats, or involving the protection of adrenalectomized rats against the effects of a low environmental temperature (Selye and Schenker assay). Dr. Vogt has successfully applied the second of these methods to the estimation of hormone activity in the suprarenal blood of experimental animals. The results were expressed, by comparison with commercial extracts prepared from slaughter-house adrenal glands, in terms of the amounts of slaughter-house material required for the preparation of crude extract sufficient to give the observed physiological activity. On this basis the normal output of adrenal hormones in a 10-kgm. dog is 720 gm./hr., which is approximately equivalent to 54 mgm./day of 17-hydroxy-11-dehydrocorticosterone.

These results confirm the idea that the hormones are not stored in the gland in the active form to any appreciable extent, but are produced from an inactive precursor and immediately released into the circulation. Furthermore, since arterial or heart blood contains no significant activity, it appears that the secreted steroids are rapidly inactivated in the tissues. The rate of hormone secretion is greatly increased by stimulation of the splanchnic nerves, and since this effect can be duplicated by the intravenous infusion of adrenaline, it appears to be an indirect one via the adrenal medulla. It has been found possible to assay the adrenal steroids liberated in the isolated perfused adrenal gland. In such a perfused preparation a prolonged increase in the rate of secretion can be induced by the addition of corticotrophin to the circulating blood. In the absence of any such added stimuli, the isolated glands have been found to secrete continuously at a steady rate which lies within the limits observed in the experiments on the whole animal. Experiments of this type are obviously of great value, since the conditions are much more experimentally controllable than those in experiments on the intact animal.

In the course of his summing-up of the discussion, the chairman (Prof. S. Zuckerman) pointed out the paradox that although extra dietary sodium chloride will maintain an adrenalectomized animal in good health under controlled environmental conditions, the secretory activity of the adrenal glands is normally surprisingly high and can rise to very high levels under the influence of environmental stimuli. What is the importance to the body of this normal secretory activity of the adrenal glands, and what is the fate of the secreted steroids? Although the adrenal secretion may not be essential for survival under some conditions, and does not necessarily initiate reactions in the body but hastens or retards enzymically controlled processes, it is important not to under-estimate the importance of adrenal hormones, particularly under conditions of stress. The present multiplicity of apparently unrelated experimental data does not yet allow any simple generalization about the function of adrenal hormones in general; but the importance of correlating observations which can accurately be correlated in a limited way should not be neglected.

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# OBITUARIES

## Dr. S. Monckton Copeman, F.R.S.

SYDNEY ARTHUR MONCKTON COPEMAN, the eldest son of the Rev. Canon A. C. Copeman, was born at Norwich on February 21, 1862, and was educated at King Edward VI School, Norwich, and at Corpus Christi College, Cambridge. After obtaining a second class in the Natural Sciences Tripos in 1882, he went to St. Thomas's Hospital and took the M.B. Cambridge in 1886. He proceeded to the M.D. in 1890 and was elected F.R.C.P. in 1899. For a short time he was assistant lecturer on physiology and morbid histology at St. Thomas's. In 1891 he became a medical inspector of the Local Government Board, and all his active medical life was spent in the service of that Department and, afterwards, as a medical officer of the Ministry of Health. In the same year he was one of the founders of the Medical Research Club.

Medical research early engaged Copeman's attention, and among his early papers was one on the specific gravity of the blood in disease and another on hæmatoporphyrin in urine. It is, however, by his work on variola and vaccinia that he established his scientific reputation.

The early experiments of Ceely (1839–40), of Badcock (1840) and of Klein (1892) had demonstrated that typical vaccinia may be produced in the calf by the inoculation of variolous matter. In 1892 Copeman showed that it was possible to inoculate calves with variolous lymph taken from a girl suffering from smallpox, that the inoculated calves showed vesiculation, that the results obtained became greatly modified in the course of successive removes, and further, that animals which had been thus treated were no longer susceptible to vaccination. In the same year he proved that rhesus monkeys are susceptible not only to vaccination but also to smallpox. He next investigated the degree of protection against smallpox afforded in the monkey by previous vaccination and the protection against vaccination afforded by variolation; and went on to compare the effect produced by the use of human and of calf vaccine respectively. By passing smallpox virus through monkeys and then vaccinating calves from the monkeys, he produced typical vaccinia, which gave excellent strains of vaccine lymph.

In 1865 a Commission, appointed by the Society of Medical Sciences at Lyons, having Chauveau at its head, had reported to the effect that cowpox and smallpox were dual diseases. Copeman's work supported the view that cowpox and horsepox are variola modified by transmission, or, as he phrased it: "Smallpox and vaccinia are both of them descended from a common stock—from an ancestor, for instance —which resembled vaccinia far more than it resembled smallpox".

In 1891, at the International Congress of Hygiene, Copeman described his technique for the bacteriological purification and preservation of vaccine lymph by the admixture of glycerin. This, as he observed, was no new device, but he was the first to demonstrate the selective action of glycerin in eliminating extraneous organisms from the lymph without affecting the specific virus. Later, with F. R. Blaxall, he showed that glycerin is superior to soft paraffin and lanolin in inhibiting the growth of these micro-organisms.

With Dr. Gustav Mann, Copeman collaborated in a study of the histology of vaccinia and investigated other aspects of variola and vaccinia.

As a result of Copeman's work, 'arm-to-arm' vaccination with its attendant risks was abolished, and vaccination was made a much safer and simpler operation. His work was generally adopted by the Royal Commission on Vaccination.

Copeman's discoveries are chiefly recorded in the *Proceedings of the Royal Society*, the annual reports of the Medical Officer of the Local Government Board, and in his Milroy Lectures under the title of "The Natural History of Vaccinia" (1898). He was elected a fellow of the Royal Society in 1903. He received many distinctions; for example, the Buchanan Gold Medal of the Royal Society in 1902; the Cameron Prize of the University of Edinburgh in 1899, and the Fothergill Gold Medal of the Medical Society of London in the same year; and the Jenner Medal of the Royal Society of Medicine (1925) and the Gold Medal of the International Faculty of Sciences (1938).

Although Copeman was employed in numerous administrative inquiries for the Central Health Department both at home and abroad, acted as Government delegate and served on many departmental committees, his real interest lay in scientific research, and his alert mind, fertile in new ideas, was directed to various subjects of investigation. During his later years at the Ministry of Health, he paid special attention to the problem of cancer, and his report with Prof. Major Greenwood on "Diet and Cancer with special reference to the Incidence of Cancer upon Members of certain Religious Orders" opened a new field of inquiry. In 1928, at the International Cancer Congress held in London, he read a paper on irradiated fluorescein in the treatment of cancer. He was a member of the Ministry of Health's Departmental Committee on Cancer, where his advice and ripe experience proved of much value. He was also a pioneer in immunization against diphtheria in Great Britain. During the First World War, Copeman was in charge of the Hygiene Department of the Royal Army Medical College, and helped with others to improve preventive medicine in the field. Endowed with untiring energy and enthusiasm, he took an active part in many medical societies and organisations. He was a keen naturalist and biologist and, as a member of the council of the Zoological Society, did much to develop its work on scientific lines.

On his official retirement in 1925, Copeman interested himself in local government as a member of the London County Council and chairman of the Public Health Committee of the Hampstead Borough Council. He died on April 11, at the age of eighty-five. To the end he kept himself informed of modern progress in medical research. He had a distinguished appearance and a generous and kindly disposition. A man of wide culture, he was a delightful companion. Copeman did much to maintain the high standard of English State medicine. A. S. MacNalty

## Prof. W. L. Valentine

Willard Lee Valentine, editor of *Science* since January 1, 1946, died at his home in Alexandria, Virginia, on April 5. Sudden heart failure ended his career at the age of forty-two. He is survived by his wife, Norma Lawrence Valentine, and two children, Richard and Virginia.

Dr. Valentine was born in Chillicothe, Ohio, on December 2, 1904. He received the A.B. degree at Ohio Wesleyan University in 1925 and the Ph.D. at Ohio State University in 1929. During his years of graduate study, he served as assistant in mathematics and psychology, and later as instructor at Ohio Wesleyan and as instructor in psychology at Ohio State Universities.

Upon receiving his Ph.D. degree, he became a member of the Psychology Department at Ohio State University, first as assistant professor and later as associate professor. His duties there during 1929–40 were principally the direction and co-ordination of the work of the numerous instructors who gave the introductory courses in psychology. His strong interest in improving the teaching given to elementary psychology students led him during these years to write a manual of psychological experiments and to edit several collections of readings in psychology. His work during these years gave many students more interesting, and more experimental, courses than were often taught formerly.

In 1940 Dr. Valentine moved to Northwestern University in Evanston, Illinois, where he served as professor of psychology and chairman of the department until 1945.

From 1937 until his death he was treasurer of the American Psychological Association. During 1938–45 he served as business manager of the Association's publications. His careful supervision strengthened the journals financially, increased their number, and made them available to a steadily increasing group of subscribers.

His editorial skill and his experience with psychological publications led to his appointment as editor of *Science* when that journal came under the editorial direction of the American Association for the Advancement of Science. From the autumn of 1945, when he began planning his first issue, until his death, he devoted himself to making *Science* a news magazine of interest to workers in all fields of science. The format was improved and the scope of articles broadened. Material of general interest to all men of science, such as discussions of the Science Foundation bills being debated by Congress, became, under his editorship, a prominent feature of the journal.

His untimely death has ended a life of service to psychologists and scientific workers in other fields, just as Dr. Valentine was reaching his prime.

Dael L. Wolfle

## Mr. C. W. Hobley, C.M.G.

Charles William Hobley died at his residence at Oxted, Surrey, on March 31 in his eightieth year. For the past six years or so his health had been frail and his activity was considerably reduced. He will be best remembered for his pioneer work for the prevention of the threatened extermination of some of the more graceful mammals. He was also an authority on the life, both human and wild, of East Africa.

Born in 1867, the son of William Hobley, of Chilvers Coton, near Nuneaton, Warwickshire, Hobley was

educated at Mason College (now part of the University of Birmingham), specializing in geology. In 1890 he was appointed to a post as geologist in the service of the Imperial British East Africa Company, and as the result spent the whole of his official life in East Africa. When the region was taken over by the Government and became the East Africa Protectorate, Hobley was transferred to the administrative side, being appointed a sub-commissioner in 1894, and as time went on was allotted posts of ever greater responsibility. He was acting deputy commissioner from 1903 until 1904 and again from 1906 until 1907, acting commissioner in 1904, and acting senior commissioner in 1907. In 1912 he was placed in charge of the Seyidieh Province, and during 1912–20 he was an official member of the Legislative Council of the East Africa Protectorate as well as Commissioner of Mines. Upon the outbreak of the First World War, Hobley was appointed chief political officer to the British Expeditionary Force in East Africa, his services receiving mention in dispatches. He retired from the Colonial Service in 1921. He had been awarded the C.M.G. in 1904. An important valley on the east side of Mount Kenya was named after him.

All his life Hobley retained a keen interest in Nature, especially in East Africa, where he varied his official duties by making several extensive and important collections for the British Museum. He belonged to the Royal Anthropological Institute, the Royal Geographical Society, and the Geological Society, and served on the councils of the first two in 1931 and of the third in 1930; he was also a corresponding fellow of the Zoological Society. In 1930 he became a member of the Advisory Board of the Geological Survey of Great Britain. His greatest services were, however, rendered to the movement to provide protection for animal species which otherwise, owing to ruthless commercial exploitation, would seriously diminish in numbers. In 1923 he was appointed secretary of the Society for the Preservation of the Fauna of the Empire, and held the post for thirteen years, until in 1936 health reasons compelled him to take life more easily. In 1931 he represented the Society at the Second International Conference for the Protection of Nature held at Paris. It may be recalled that as an immediate consequence of this Congress a conference of the African Powers was held in London in 1933, which produced the Convention for the Protection of the Fauna and Flora of Africa now in force. His services to the Society were recognized by his election as vice-president.

Hobley married the daughter of the late Thomas Turner, of Sutton Coldfield, in 1905; she died in 1940. The son and daughter of the marriage survive.

G. F. Herbert Smith

### Prof. Paul Reiss

Paul Reiss, *professeur agrégé* in the Faculty of Medicine at Strasbourg, was killed at St. Just (Cantal) on June 22, 1944, when helping to evacuate wounded members of the *Maquis*. He was forty-three years old. Reiss was born at Strasbourg. He was both personally attractive and one of the more brilliant of the younger French biologists. He was a pupil of Fred Vlès. His early work was on the relation of *p*H and *r*H to the physico-chemical equilibria in cells, from which he went on to enzyme studies, and thence to cancer work. He is buried in the crypt of the Sorbonne with others who fell in the Resistance Movement.

H. Munro Fox

We regret to announce the following deaths:

Dr. Leopold Portheim, formerly director of the Biological Research Institute of the Academy of Science in Vienna, on May 21, in London.

Prof. W. Rogowski, professor of electrotechnics at the Technical Highschool, Aachen, well known before the War for his electrotechnical work.

# NEWS and VIEWS

## Research in Mechanical Engineering

The Government, through the Department of Scientific and Industrial Research, is setting up a special organisation to carry out scientific research in mechanical engineering to meet and, still more, to anticipate, the needs of industry and Government departments. The eventual annual expenditure will be in the region of £250,000–£350,000, although it is unlikely that this figure can be reached for some years because of the present difficulties in obtaining suitably qualified staff and buildings. The activities of the new body are intended mainly to supplement the research carried on in other research organisations in Great Britain, and will largely be confined to those fundamental problems which underlie all mechanical engineering. Thus the subjects in which research is expected to be carried out are: (*a*) properties and strength of materials; (*b*) mechanics of solids, stress, stability and vibration of structures; (*c*) mechanics of fluids; aerodynamics, gas dynamics and hydraulics in their mechanical engineering applications; (*d*) lubrication, wear and mechanical engineering aspects of corrosion; (*e*) mechanisms, engineering metrology, and noise control; (*f*) mechanics of formation of materials; machine shaping of materials; (*g*) heat transfer, heat exchange apparatus and applied thermodynamics. The location of the research station has not yet been decided. For the time being much of the work will be carried out at the National Physical Laboratory, while other work will be arranged for at universities and other institutions. It is clear that the new station will have to work in the closest liaison with the N.P.L., which has a long tradition, in its Engineering Division, of engineering research of high quality, and which will provide the nucleus, in due course, of the new organisation. Unfortunately no land is available close at hand for the building of the new station, which will require a considerable area.

Dr. G. A. Hankins, superintendent of the Engineering Division of the National Physical Laboratory, has been appointed director of mechanical engineering research. As with all other research organisations in the Department of Scientific and Industrial Research, the director will be advised by a board, the members of which will serve in their personal capacity and not as representatives of any organisation to which they may belong. The composition of the Mechanical Engineering Research Board is as follows: Dr. H. L. Guy (*chairman*); Mr. L. Akehurst, operative, London Passenger Transport Board; Prof. R. N. Arnold, professor of engineering, University of

Edinburgh; Dr. S. F. Dorey, chief engineer surveyor, Lloyd's Register of Shipping; Sir Claude Gibb, of C. A. Parsons & Co., Ltd.; Dr. H. J. Gough, engineer in chief, Lever Bros. & Unilever, Ltd.; Sir William Halcrow; Mr. M. B. Hoseason, Brush Electrical Co., Ltd.; Dr. C. H. Lander, principal, Military College of Science; Prof. N. F. Mott, Melville Wills professor of theoretical physics, University of Bristol; Prof. D. M. Newitt, professor of chemical engineering, Imperial College of Science and Technology, London; Sir Ewart Smith, of Imperial Chemical Industries, Ltd.; Prof. H. W. Swift, professor of engineering, University of Sheffield; Dr. C. Sykes, director, Brown–Firth Research Laboratories.

## British Committee for Co-operation with U.N.E.S.C.O. in the Natural Sciences

At the invitation of the Ministry of Education, the Royal Society has set up a committee to co-operate with the United Nations Educational, Scientific and Cultural Organisation in the field of the natural sciences. The Committee's terms of reference are: (i) on behalf of the United Kingdom, to co-operate with U.N.E.S.C.O. in the field of the natural sciences; (ii) to report to the Council of the Royal Society and to the Minister of Education.

The Committee consists of a chairman, Prof. E. D. Adrian (foreign secretary of the Royal Society), and representatives (as indicated in brackets) of the following bodies: Royal Society (Dr. C. H. Desch, Dr. J. Needham, Prof. H. H. Read); chairmen of the seven British National Committees (Astronomy—Sir Harold Spencer Jones; Biology—Prof. H. M. Fox; Chemistry—Sir Ian Heilbron; Geodesy and Geophysics—Prof. J. Proudman; Geography—Prof. H. J. Fleure; Physics—Prof. N. F. Mott; Scientific Radio—Sir Robert Watson-Watt); Ministry of Education (Mr. Ritchie Calder, Prof. H. J. Fleure, Sir Clive Forster-Cooper); Advisory Council on Scientific Policy (Dr. A. E. Trueman); British Association (Dr. E. Hindle, Dr. O. J. R. Howarth); British Council (Dr. N. Howard Jones, Miss Nancy Parkinson); Association of Scientific Workers (Prof. J. D. Bernal); Science Masters' Association (Mr. J. P. Stephenson); Department of Scientific and Industrial Research (Sir Edward Appleton); Medical Research Council (Sir Edward Mellanby); Agricultural Research Council (Sir John Fryer); secretary of the Universities Bureau of the British Empire; and *ex officio*, the president, treasurer and one secretary of the Royal Society. The joint secretaries of the Committee are Mrs. J. J. Hawkes, of the Ministry of Education, and Dr. D. C. Martin, assistant secretary of the Royal Society. In accordance with the proposal by the Ministry of Education, the Council of the Royal Society has agreed that other important scientific organisations in the United Kingdom should be notified of the existence of the Committee and invited to transmit to the secretariat any proposals which they may wish to initiate. The first meeting of the Committee will be held on June 27.

## Agricultural Science at Newcastle-upon-Tyne

The scope of instruction and research in agriculture at King's College, Newcastle-upon-Tyne, is to be extended. Two new chairs have been founded, the occupants of which will carry out their work under the direction of Prof. R. W. Wheldon, the present head of the department. The Loveday Report recommended the setting-up of post-graduate schools in agriculture and farm machinery for graduates in engineering who intend to become agricultural engineers, and in engineering and farm machinery for graduates in agriculture who intend to become farm mechanization experts. King's College, which has a strong engineering school, has been selected as a centre for this specialized work.

Lieut.-Colonel Ewen McEwen has been appointed the first professor of engineering in the Faculty of Agriculture. At University College, London, in 1935 he gained a first-class honours in mechanical engineering. Until 1942 he held a research appointment with David Brown and Sons (Huddersfield), Ltd., and afterwards served with the R.A.O.C. and R.E.M.E. More recently, as assistant chief engineer in the Fighting Vehicles Design Department of the Ministry of Supply, he has become conversant with fundamental problems of traction in relation to soil structure.

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## British Committee for Co-operation with U.N.E.S.C.O. in the Natural Sciences

At the invitation of the Ministry of Education, the Royal Society has set up a committee to co-operate with the United Nations Educational, Scientific and Cultural Organisation in the field of the natural sciences. The Committee's terms of reference are: (i) on behalf of the United Kingdom, to co-operate with U.N.E.S.C.O. in the field of the natural sciences; (ii) to report to the Council of the Royal Society and to the Minister of Education.

The Committee consists of a chairman, Prof. E. D. Adrian (foreign secretary of the Royal Society), and representatives (as indicated in brackets) of the following bodies: Royal Society (Dr. C. H. Desch, Dr. J. Needham, Prof. H. H. Read); chairmen of the seven British National Committees (Astronomy—Sir Harold Spencer Jones; Biology—Prof. H. M. Fox; Chemistry—Sir Ian Heilbron; Geodesy and Geophysics—Prof. J. Proudman; Geography—Prof. H. J. Fleure; Physics—Prof. N. F. Mott; Scientific Radio—Sir Robert Watson-Watt); Ministry of Education (Mr. Ritchie Calder, Prof. H. J. Fleure, Sir Clive Forster-Cooper); Advisory Council on Scientific Policy (Dr. A. E. Trueman); British Association (Dr. E. Hindle, Dr. O. J. R. Howarth); British Council (Dr. N. Howard Jones, Miss Nancy Parkinson); Association of Scientific Workers (Prof. J. D. Bernal); Science Masters' Association (Mr. J. P. Stephenson); Department of Scientific and Industrial Research (Sir Edward Appleton); Medical Research Council (Sir Edward Mellanby); Agricultural Research Council (Sir John Fryer); secretary of the Universities Bureau of the British Empire; and *ex officio*, the president, treasurer and one secretary of the Royal Society. The joint secretaries of the Committee are Mrs. J. J. Hawkes, of the Ministry of Education, and Dr. D. C. Martin, assistant secretary of the Royal Society. In accordance with the proposal by the Ministry of Education, the Council of the Royal Society has agreed that other important scientific organisations in the United Kingdom should be notified of the existence of the Committee and invited to transmit to the secretariat any proposals which they may wish to initiate. The first meeting of the Committee will be held on June 27.

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in 1847. This exhibition, covering a century of mechanical engineering, is divided into several sections including mechanical plant for power stations; locomotives; automobile, marine and aero-engines; hydraulic and handling machinery, etc. Important historical objects are shown in their appropriate galleries. Modern exhibits are displayed in Gallery 1. Scale-models made specially for this exhibition include the steam turbines of the R.M.S. *Queen Elizabeth* and a Southern Railway 'West Country' steam locomotive. Most exhibits, such as automobile and aero-engines, models of high-pressure boilers, steam and gas-turbines, have never been shown in the Science Museum before.

## Conference on Liquid Helium

A CONFERENCE on liquid helium will be held at the Clarendon Laboratory, Oxford, during June 27–28. The programme includes discussions on the general and quantum theories of liquids (Prof. Max Born and Dr. H. S. Green respectively), the 'cage' model of a liquid (Dr. H. N. V. Temperley), zero-point energy of thin helium films (Prof. N. F. Mott), properties of helium films (K. R. Atkins, J. B. Brown and Dr. K. Mendelssohn) and Heisenberg's new theory of superconductivity (Prof. M. H. L. Pryce). Particulars of the conference can be obtained from Prof. F. E. Simon, Clarendon Laboratory, Parks Road, Oxford.

## Summer Symposium on Sound Absorption and Reverberation

THE Acoustics Group of the Physical Society is holding a Summer Symposium on June 26 at the Royal Institute of British Architects. The discussions will open at 10 a.m. with a paper on "Panel Absorbents of the Helmholtz Type", by Prof. P. V. Bruel, of the University of Gothenburg. In the afternoon Mr. J. Moir, of the British Thomson-Houston Co., Ltd., will speak on "Reverberation Time as an Index of Room Performance". The meeting is open to all who are interested in acoustics, but they are asked to notify the joint secretaries of the Acoustics Group at the offices of the Physical Society at 1 Lowther Gardens, Prince Consort Road, London, S.W.7, if they intend to be present, in order that necessary arrangements can be made.

## Scottish Summer Schools in Health Education

EACH year the Scottish Council for Health Education sponsors three residential summer schools at convenient centres. These schools are of interest to doctors, teachers, health visitors, nurses, youth leaders and others, who feel that integrated courses in physiology, psychology and social medicine will help them in their professional work. The schools are residential, last for fourteen days, and provide a total of twenty-seven lectures by men and women eminent in their special fields. Students may enrol for an elementary or intermediate course at the Universities of Edinburgh and St. Andrews, respectively, both from July 26 to August 9, or take an advanced course at Strathpeffer Spa during August 8–22. There are still a number of vacancies at the Edinburgh and St. Andrews schools, but only a very few at Strathpeffer, which, already, has attracted nearly a hundred students. Further information can be obtained from the Secretary, Scottish Council for Health Education, 3 Castle Street, Edinburgh, 2.

## University of London: Appointments

THE following appointments in the University of London have been announced: Dr. Harry Jones, reader in mathematics at the Imperial College of Science and Technology, to the University chair of mathematics tenable at the College as from October 1, 1946; Dr. Alan Kekwick, to the University chair of medicine tenable at Middlesex Hospital Medical School as from October 1, 1946; Mr. M. E. L. Mallowan, to the University chair of western Asiatic archæology tenable at the Institute of Archæology as from May 1, 1947; Mr. Mallowan has conducted excavations at Arpachinah, the first settlement of the Tel Halaf culture to be scientifically excavated, also at Chagar Bazar and in the Tel Brak district; Dr. H. W. Miles, during 1943–46 adviser and senior lecturer in agricultural entomology in the University of Bristol, to the University chair of horticulture tenable at Wye College as from May 1, 1947; Mr. R. S. Sayers, during 1935–45 lecturer in economics at Pembroke, Exeter and Corpus Christi Colleges, Oxford, to the Sir Ernest Cassel chair of economics with special reference to banking tenable at the London School of Economics as from May 1, 1947; Mr. Herbert Tout, senior lecturer in economics at the University of Bristol, to the University readership in political economy tenable at University College as from October 1, 1947; Dr. W. J. Hickinbottom, since 1927 lecturer in chemistry in the University of Birmingham, to the University readership in organic chemistry tenable at Queen Mary College as from October 1, 1947; Dr. E. S. Horning, formerly of the permanent scientific staff at the Imperial Cancer Research Fund Laboratories, to the University readership in experimental pathology tenable at the Royal Cancer Hospital as from May 1, 1947; Dr. F. C. Tompkins, lecturer at King's College, to the University readership in physical chemistry tenable at the Imperial College of Science and Technology as from October 1, 1947.

The title of professor emeritus of chemistry in the University has been conferred on Dr. James F. Spencer on his retirement from Bedford College. The title of professor of comparative education in the University has been conferred on Dr. J. A. Lauwerys in respect of the post held by him at the Institute of Education.

The degree of D.Sc. has been conferred on O. V. S. Heath (Imperial College of Science and Technology); and S. S. Joski (University College).

## Announcements

SIR LIONEL WHITBY, regius professor of physic in the University of Cambridge, has been elected master of Downing College, Cambridge, in succession to the late Sir Herbert Richmond.

A NATIONAL meteorological service has been established in Portugal under the direction of Prof. H. Amorim Ferreira. The headquarters of the new service is Serviço Meteorológico Nacional, Largo de Santa Isabel, 2–Lisboa (Portugal).

THE following officers were elected at the annual general meeting of the Society for Endocrinology held at University College, London, on May 29: *Chairman:* Dr. A. S. Parkes; *Secretary:* Dr. S. J. Folley, National Institute for Research in Dairying, Shinfield, Nr. Reading; *Treasurer:* Dr. C. W. Emmens; *Editor of the Society's Proceedings:* Prof. S. Zuckerman; *Members of Committee:* Dr. P. M. F. Bishop; Dr. C. H. Gray; Mr. P. C. Williams; Prof. F. G. Young.

ERRATUM. In the communication "Temperature-Dependence of Magnetic Susceptibility of Annealed and Cold-worked Copper" (*Nature*, April 19, p. 537), par. 2, line 4, for "0·005 per cent" read "0·0005 per cent".

# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications*

## Ternary and Quaternary Fission of Uranium Nuclei

AFTER our experimental proof of the existence of tripartition and quadripartition (ternary and quaternary fission) of $U^{235}$ by means of photographic emulsion[1,2], a systematic study of the mass and kinetic energy of fission fragments has been made with the Ilford Nuclear Research $C_2$ plate. The experimental conditions were similar to those of previous work. $C_2$ plates soaked with 10 per cent solution of uranyl nitrate were bombarded with slow neutrons produced near the beryllium target of the cyclotron of the Collège de France.

The results of the first series of experiments can be summarized in the following[3,4].

*Tripartition.* Usually two of the fragments are heavy ($m_1$, $m_2$) and the third one is light ($m_3$) (Fig. 1). The mean ranges of $m_1$ and $m_2$ are 1·9 and 2·3 cm. of air equivalent, while that of $m_3$ varies from 2 to 44 cm., the most frequent value being about 25 cm. The direction of emission of $m_3$ is nearly perpendicular to that of $m_1$ and $m_2$. The mass distribution of $m_1$ and $m_2$ has mean values of 99 and 131, whereas in the usual binary fission the most frequent masses are 96 and 138. The third fragment, $m_3$, seems to have two probable values, one about 5, the other about 9. Some cases, which could be interpreted as tripartitions, could be also interpreted by the mechanism of projection of atoms of carbon, nitrogen or oxygen ($m \sim 14$) or silver or bromine ($m \sim 90$) by a fission fragment; fission tracks of this kind were not counted in the statistics of tripartition. The total kinetic energy of the three fragments, about 155 MeV.[5], slightly higher than that of the usual binary fission fragments (150 MeV.), is in good agreement with the theoretical prediction[6]. The frequency of tripartition is about 1/300 of that of bipartition (usual fission process).

A parallel and independent investigation by Demers[7] shows that the third light fragment (considered as an α-particle) is emitted within $2 \times 10^{-14}$ sec. after the act of division. This is in good agreement with our hypothesis of tripartition, namely, that three fragments are emitted in an interval of time comparable with the mean life-time of the compound nucleus $_{92}U^{236}$. The frequency observed by Demers is also in agreement with ours.

Recently, we have observed a particular case in which the third fragment is much heavier (Fig. 2). The calculated masses are about 127, 77 and 32 respectively. The three fragments are almost coplanar, their ionizations are much higher than that of α-particles and the total kinetic energy is about 142 MeV. This observation and the direction of emission of $m_3$ support the explanation in terms of tripartition[8,9] which is possible with a large positive amplitude of the deformation due to the fourth harmonic of the liquid drop (Bohr's liquid drop model of the nucleus). The relative sizes of the fragments (droplets) depend upon the amplitudes and the phases of deformations due to the second and fourth harmonics. Consequently, it is natural that the third fragment should have different values of mass such as we have observed. An analysis of fission fragments in the region of lower atomic weight by means of the mass spectrograph with a strong neutron source might give more information concerning the mass distribution of third fragment.

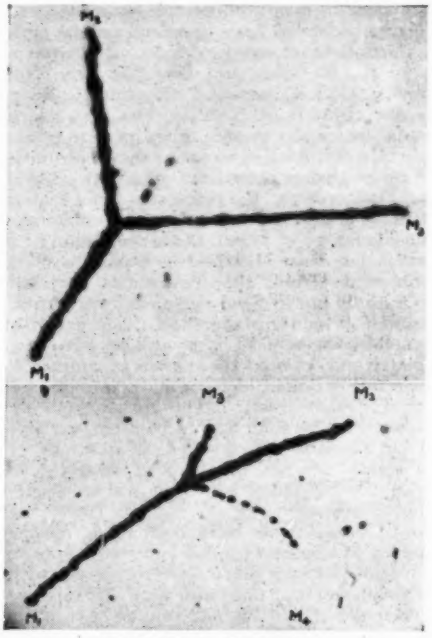


Fig. 2 (above); Fig. 3 (below)

Fig. 2. TRIPARTITION OF URANIUM NUCLEUS WITH THREE FRAGMENTS OF COMPARABLE MASSES: $m_1 = 127$; $m_2 = 77$; $m_3 = 32$

Fig. 3. QUADRIPARTITION OF URANIUM NUCLEUS

*Quadripartition.* The first case of quadripartition has already been published in detail[2,3]. Another one is shown in Fig. 3. The four fragments are not coplanar. The calculated masses are: $m_1 = 84$, $m_2 = 76$, $m_3 = 72$ and $m_4 = 4$, with a total kinetic energy about 90–95 MeV. If the internal excitation energies of the fragments are about the same both for binary and quaternary fissions, the observed total kinetic energy for the latter is in good agreement with that estimated by Bohr and Wheeler. The frequency of quadripartition is about 1/3,000 that of bipartition.

A detailed report of this work will be published shortly in the *Journal de Physique et Le Radium*.

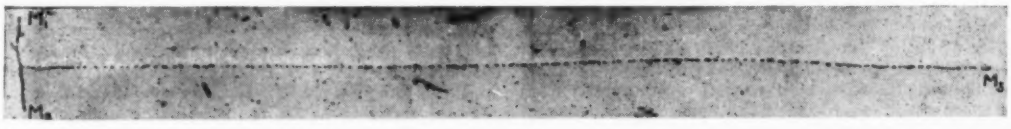


Fig. 1. TRIPARTITION OF URANIUM NUCLEUS WITH LIGHT THIRD FRAGMENT (ITS RANGE IN STANDARD AIR = 44 CM.). THE TWO BRANCHES ON $M_1$ TRACK ARE DUE TO NUCLEAR COLLISIONS OF $M_1$ WITH KNOWN NUCLEI CONTAINED IN PHOTOGRAPHIC EMULSION $m_1 = 110$, $m_2 = 120$, $m_3 = 6 \pm 1$. Total kinetic energy ~ 179 MeV.



would raise serious problems. The most attractive

THE following appointments in the University of London have been announced: Dr. Harry Jones, par. 2, line 4, for "0·005 per cent" read "0·0005 per cent".



*Note added in proof.*—Since this letter was written, two communications have appeared on the emission of a third light charged particle in the fission of uranium (L. L. Green and D. L. Livesey, *Nature*, March 8, p. 332; G. Farwell, E. Segrè and C. Wiegand, *Phys. Rev.*, March 15, p. 327). The first one, using the same technique as ours, gives similar results on the direction of emission and the range distribution of $m_3$ of range greater than 1 cm. of air equivalent. It shows, furthermore, the existence of an important short-range group. The second one, using the method of coincidence, gives 23 cm. as the maximum range of $m_3$ which has been identified as α-particle. Within experimental errors, the frequencies observed by these authors are in good agreement with ours.

In order to confirm the short-range group of $m_3$ indicated by Green and Livesey, we have re-examined our plates and counted those cases in which a short-range track is linked in the middle straight part of the main fission tracks. The statistics show that particles of range from 3 mm. to 3 cm. are present, the most probable range being about 8 mm. If all these tracks are really connected with the fission process, the frequency will be one short particle in 90 fission events.

Similar experiments have been made recently on the fission of uranium by fast neutrons. Short-range third light particles have been observed with the same frequency, but until now no long-range particle has been detected. Similar results have also been obtained in the case of fission of thorium by fast neutrons (observation made by the senior author in collaboration with Mrs. H. Faraggi).

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HO ZAH-WEI
L. VIGNERON
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March 15.

[1] Tsien San-Tsiang, Chastel, R., Ho Zah-Wei and Vigneron, L., *C.R. Acad. Sci., Paris*, **223**, 986 (1946).
[2] Ho Zah-Wei, Tsien San-Tsiang, Vigneron, L., and Chastel, R., *C.R. Acad. Sci., Paris*, **223**, 1119 (1946).
[3] Tsien San-Tsiang, Ho Zah-Wei, Chastel R., and Vigneron, L., *C.R. Acad. Sci., Paris*, **224**, 272 (1947).
[4] Tsien San-Tsiang, Ho Zah-Wei, Chastel, R., and Vigneron, L., *Phys. Rev.*, **71**, 382 (1947).
[5] In the previous publications, the calculation of energy was based upon the $V—R$ relation given by Boggild, Bostrøm and Lauritsen (*Kgl. Danske Videnskab. Selskab. Math.-Fys. Medd.*, **25**; 1940), assuming the total kinetic energy of binary fission fragments to be 162 MeV., instead of the more recent value, 151 MeV., from Flammersfeld, Jensen and Gentner (*Z. Phys.*, **120**, 450; 1943). Therefore, our formerly published total kinetic energy should be diminished by about 10 MeV.
[6] Bohr, N., and Wheeler, J. A., *Phys. Rev.*, **56**, 426 (1939).
[7] Demers, P., *Phys. Rev.*, **70**, 974 (1946).
[8] Present, R. D., *Phys. Rev.*, **59**, 466 (1941).
[9] Tsien San-Tsiang, *C.R. Acad. Sci., Paris*, **224**, 1056 (1947).

## An Electron Accelerator with an Air-cored Field

ARISING primarily from the fact that iron becomes saturated in the region of 10,000–20,000 gauss, high-energy ions and electrons have been obtained from cyclotrons and betatrons only by the use of magnetic fields of large orbital radii. The question has, therefore, often been raised as to the possibility of using iron-free fields of short duration, especially as fields of the highest magnitude have been obtained in this way. The following note describes an experimental resonance accelerator for electrons which uses such an air-cored field.

The principle of the accelerator has already been described[1]. Electrons are accelerated by a 1,200 Mc./s. electric field across a pair of dees situated in a magnetic field of 425 gauss. Owing to the relativity mass increase, the electrons tend to lag behind the accelerating potential, and, in order to keep them in resonance, an increasing magnetic field is superimposed on the static field. The phasing condition requires that the rate of increase of magnetic field, $dH/dt$, be less than $2\,Ve.n.H_0/m_0c^2$, where $Ve$ is the energy added to the electrons per transit of the dee gaps, $n$ is the frequency of the accelerating field, and $H_0$ is the magnitude of the static field.

A focusing static field is produced by a Helmholtz pair of coils, each of 120 turns of mean radius 11·5 cm., excited by a direct current of 48 amp. The dynamic field is also produced by a Helmholtz pair, each coil of four turns and 7 cm. radius. A condenser bank of 0·0108 μf., charged to 20,000 V., is shorted across the dynamic coils and produces a field of approximately 300 gauss at the peak of a sinusoidal oscillation of 250 kc./s. frequency. The growth of the dynamic field is synchronized with the start of the electric field pulse by using the same rotary spark modulator to control both circuits.

The dees are 2 cm. deep and 5 cm. in radius, and are constructed from wire hoops mounted perpendicularly from frames forming the dee gaps. They are situated in an evacuated glass vessel in the mid-plane of the Helmholtz coil system. The ultra-high-frequency is fed to the dees by a Lecher wire system which fans out to the width of the dee frames at the gaps. The oscillations are produced by a 25-cm. magnetron operating at 100 pulses per second, each pulse being of 1 μsec. duration, and of peak power up to 200 kW. The dee voltage is estimated to be of the order 1,000 V.

A tungsten filament, partly enclosed in a split cylindrical shield, is situated along the axis of the dees, and a small tungsten target is located at the periphery of one of the dees.

X-rays have been detected by a Geiger counter set up in the vicinity of the accelerator and are emitted at the value of the static field calculated for resonance with the electric field. The form of the resonance curve is shown in Fig. 1. Tests have been made on the X-rays produced both with and without the dynamic field operating. Absorption curves in lead are shown in Fig. 2. With the dynamic field operating it is clear that the X-ray yield is considerably increased, and there is an indication in the foot of the absorption curves that the radiation is also harder. The mean energy of the X-rays determined from the absorption coefficient in lead is approximately 60 kV.

For a constant magnetic field of 425 gauss, electrons should be able to reach energies of the order 0·5 MeV. before lagging 90° in phase behind the accelerating electric field[2]. In the present experiment, however, electrons will not attain energies greater than 100 kV. before they collide with the target at a radius of 4 cm. An experimental mean energy of 60 kV. is therefore not inconsistent with the upper limit, as it is improbable that many electrons will reach this maximum in the 1 μsec. acceleration time, and also as the radiation is from a thick target.

For a magnetic field which grows from 425 gauss to approximately 725 gauss in the micro-second acceleration-time, there should be a group of electrons which attain an energy as high as 300 kV., but an analysis of the energy spectrum to be expected of

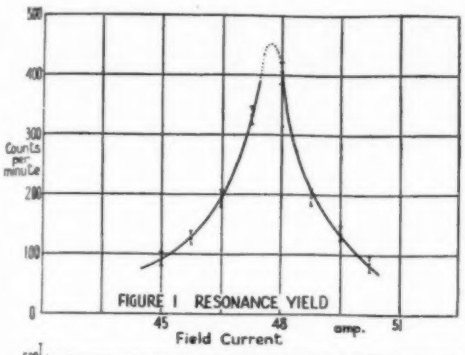


FIGURE 1 RESONANCE YIELD

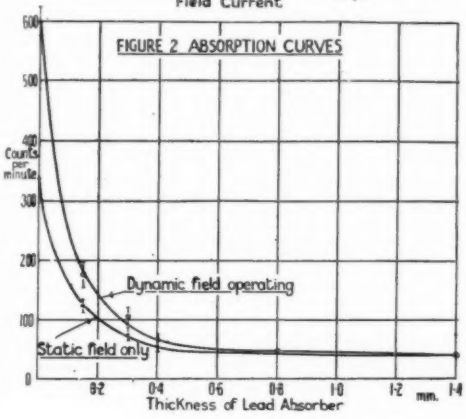


FIGURE 2 ABSORPTION CURVES

the accelerated electrons has not yet been made. It might be added that the electron energy gained per turn as a consequence of the magnetic induction effect of the dynamic field is negligible in comparison with that gained from two transits of the dee gaps.

The X-ray yield, compared tentatively with a radium source, corresponds to 0·1 millicurie, which is equivalent to a minimum peak yield of 1 curie. The yield increases rapidly with increasing dee voltage, and a ten-fold increase is obtained for an increase of filament emission to the dees from 0·5 to 5 mA.

The accelerator described above was designed to use a 1,200 Mc./s. accelerating field, mainly because the size of the maximum orbit was suited to the construction of an experimental model; but the possibility of extending the method to accelerate electrons to high energies must be considered primarily in relation to the maximum dynamic fields which can be produced. The relationship of accelerating frequency and magnetic field to maximum electron orbit is to be seen in the accompanying table. Although fields of the order of megagauss have been obtained in small volumes, the dimensions of an accelerator using centimetre accelerating fields would raise serious problems. The most attractive combination of fields appears to be in the neighbourhood of 100 Mc./s., where the relatively low magnetic fields could probably be obtained for short periods.

VARIATION OF ACCELERATOR CONSTANTS

| | | | | | |
|---|---|---|---|---|---|
| Frequency (megacycles) | 3,000 | 1,200 | 300 | 30 | 12 |
| Static field (gauss) | 1,060 | 425 | 106 | 10 | 4 |
| Dynamic field at 10 MeV. | 22,500 | 8,900 | 2,250 | 225 | 89 |
| Dynamic field at 100 MeV. | 213,000 | 85,300 | 21,300 | 2,130 | 850 |
| Maximum electron radius (cm.) | 1·6 | 4 | 16 | 160 | 400 |

Acknowledgments of helpful discussion are due to Prof. L. H. Martin, and of funds and equipment to the Council for Scientific and Industrial Research.

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March 24.

[1] Hill, R. D., *Aust. J. Sci.*, **9**, 87 (1946).
[2] McMillan, E. M., *Phys. Rev.*, **48**, 143 (1945).

## Magnetic Dispersion of γ-Ferric Oxide

An account of preliminary measurements of the magnetic properties of iron oxides at wave-lengths of 9, 6 and 3 cm. has been given in an earlier communication[1]. The powdered oxides were mixed with paraffin wax, and the properties of the mixtures determined by a wave-guide impedance method. These measurements have now been extended to a wider range of mixtures, and to wave-lengths up to 60 cm.

It has been found that the Clausius–Mosotti formula, previously used for extrapolating the properties of the mixtures to 100 per cent concentration, is of only limited validity. A more general relation between the complex permeability and permittivity, $|\mu| \exp(-i\mu')$ and $|\varepsilon| \exp(-i\varepsilon')$ of the mixture, and $v$, the proportion by volume of the oxide, has been determined. Within the limits of experimental error, $|\mu|$ and $|\varepsilon|$ obey a logarithmic law, of the type initially proposed by Lichtenecker[2] for dielectric mixtures, namely,

$$\log|\mu| = v\log|\mu_a| + (1-v)\log|\mu_0|;$$
$$\log|\varepsilon| = v\log|\varepsilon_a| + (1-v)\log|\varepsilon_0|;$$

and the magnetic and dielectric loss tangents vary linearly with $v$,

$$\tan\mu' = v\tan\mu'_a; \quad \tan\varepsilon' = v\tan\varepsilon'_a,$$

where suffix $a$ refers to the properties of the oxide, and suffix 0 to those of the paraffin wax ($\log|\mu_0| = \mu'_0 = \varepsilon'_0 = 0$).

The modified values for the magnetic properties of γ-ferric oxide previously reported[1] are included in Table 1, giving the results of measurements from 58·5 cm. to 3·08 cm.

TABLE 1

| $\lambda$ in cm. | 58·5 | 39·2 | 29·8 | 22·5 | 15·3 | 8·93 | 5·97 | 3·08 |
|---|---|---|---|---|---|---|---|---|
| $\lvert\mu_a\rvert$ | 21 | 18 | 16·9 | 12·4 | 8·0 | 3·2 | 1·4 | 0·53 |
| $\mu'_a$ | 36° | 45° | 51° | 57° | 61° | 67° | 65° | 32° |

Huttig's measurements[3] at the longer wave-lengths gave much lower values for the permeability, but this is probably attributable to porosity in the compressed samples of the oxide which he used. On this hypothesis, comparison of his value of $\varepsilon = 5{\cdot}4$ at $\lambda = 39{\cdot}5$ cm. with my value of $\varepsilon = 24$ gives $v = 0{\cdot}53$. Using this derived value of $v$, Huttig's measurements of $\mu$ have been extrapolated to 100 per cent concentration, and the results are given in Table 2. The value at infinite wave-length is extrapolated from the measurements of Welo and Baudisch[4], who used packed samples of known density.

TABLE 2

| $\lambda$ in cm. | $\infty$ | 174 | 77·5 | 39·5 |
|---|---|---|---|---|
| $\lvert\mu_a\rvert$ | 31 | 28·6 | 23·4 | 17·9 |
| $\mu'_a$ | 0 | ~0° | 29·5° | 41° |

an air-cored field.

analysis of the energy spectrum to be expected of



The general consistency of these values with those in Table 1 is striking, considering the range of the extrapolations.

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[1] Birks, *Nature*, **158**, 671 (1946).
[2] Lichtenecker, *Phys. Z.*, **19**, 374 (1918).
[3] Ministry of Supply, S.I.G.E.S.O. Report.
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## Interpretation of Complex Roots of the *S*-Matrix

It has recently been pointed out by Kramers and Heisenberg[1] that from the knowledge of the collision cross-sections between free particles, the energy-levels of the discrete states can be deduced. For this purpose the asymptotic wave function in the continuous spectrum (for one particle under the influence of a fixed centre of force),

$$\psi = \sum_l (2l+1)\, P_l \left\{ S_l(k)\, \frac{e^{ikr}}{r} - \frac{e^{-ikr}}{r}\,(-1)^l \right\} e^{-iEt}, \quad (1)$$

is considered, where $S_l$ is the diagonal form of the $S$-matrix and a function of the real momentum $k$. The stationary states follow then from the condition $k = -i\varkappa$, and

$$S_l(-i\varkappa) = 0, \qquad \varkappa > 0, \quad (2)$$

and, for relativistic particles,

$$\varepsilon = +\sqrt{m^2 - \varkappa^2}.$$

It is evidently necessary that $\varkappa < m$. The upper half of the $k$-plane ($\varkappa < 0$) gives only a repetition of the same physical facts if the roles of zeros and poles of $S$ are interchanged.

It was further pointed out by Møller[2] that (2) can be generalized so as to give also the levels of decaying radioactive states with their decay constants, through the condition

$$\left.\begin{aligned} &S_l(k' - i\varkappa) = \infty \\ &\varepsilon = +\sqrt{m^2 + k^2} = W - i\lambda \end{aligned}\right\} \varkappa > 0. \quad (3)$$

If $k' > 0$, then also $\lambda > 0$ and

$$\psi_l \sim \frac{e^{ik'r}}{r}\, e^{-iWt}\, e^{+\varkappa r}\, e^{-\lambda t}.$$

This describes an outgoing wave with decay constant $2\lambda$ (the exponential increase $e^{+\varkappa r}$ is due to particles which have been emitted a 'long time ago'). For $k' < 0$, the wave-function describes just the reverse process. It is here evidently necessary that $W > m$. This condition defines a certain region $k'^2 < \dfrac{m^2\varkappa^2}{m^2 + \varkappa^2}$ in the lower half of the $k$-plane where poles are meaningless.

Møller stated that $S_l$ can have no zeros in the right lower quadrant of the $k$-plane except on the imaginary axis, where the zeros give the stationary states with energy less than $m$. We wish to point out that, in certain modern theories where particles can be created and annihilated, complex zeros of $S$ in the lower half plane also have a simple interpretation. Let $S_l = 0$ for $k = k' - i\varkappa$, $\varepsilon = W - i\lambda$ ($\varkappa > 0$). Consider first the case $k' > 0$, and therefore $\lambda > 0$. In every case the energy $W$ must be positive. The wave function is then

$$\psi_l \sim \frac{e^{-ik'r}}{r}\, e^{-\varkappa r}\, e^{-iWt}\, e^{-\lambda t}. \quad (4)$$

This describes an ingoing, decaying wave. As can easily be verified, the equation of continuity (conservation of particles) is satisfied in every point except at $r = 0$. The wave is therefore swallowed up by the centre of force. It is true that such solutions cannot occur in ordinary wave mechanics but can occur in theories, for example, in the meson-theory, or the theory of β-decay, where particles can be created or annihilated. The capture of a $K$-electron would be one example. It is significant that in none of these theories is a convergent Hamiltonian known to exist. Again the case $k' < 0$, $\lambda < 0$ describes the reverse process. There is no restriction as to the value of $W$, except $W > 0$.

As an example for the Kramers – Heisenberg theorem for which no Hamiltonian exists, we have studied the $S$-matrix of a nucleon-meson system in the theory of damping[3]. Neglecting all multiple processes, and considering longitudinal mesons and the charged theory only, $S$ is given by (only for $l = 0$, $S \neq 0$), putting the meson mass $m = 1$,

$$\begin{aligned} S &= \frac{1 + ig^2\, k^3/\varepsilon}{1 - ig^2\, k^3/\varepsilon} && \text{for a proton and positive meson (total charge 2)} \\ S &= \frac{1 - ig^2\, k^3/\varepsilon}{1 + ig^2\, k^3/\varepsilon} && \text{for a proton and negative meson (total charge 0)} \\ \varepsilon &= \sqrt{1 + k^2}. \end{aligned} \quad (5)$$

It was shown that for total charge 2 one stationary state with $k \sim -i$, $\varepsilon \sim g^2$ (approximately) exists, ($g^2 \ll 1$). Applying the foregoing to (5), we have in addition the following complex roots and poles of $S$, with positive real part of the energy :

$$\begin{aligned} S = \infty \text{ charge 2.}\quad k &= \frac{1}{g}\,\frac{1-i}{\sqrt{2}}, \ \varepsilon = \frac{1}{g}\,\frac{1-i}{\sqrt{2}} \\ k &= -\frac{1}{g}\,\frac{1+i}{\sqrt{2}}, \ \varepsilon = \frac{1}{g}\,\frac{1+i}{\sqrt{2}} \end{aligned} \quad (6)$$

$S = 0$, charge 0. The same values of $k$ and $\varepsilon$ as in (6).

No solutions of $S = 0$, charge 2, or $S = \infty$, charge 0, exist with $k$ in the lower half-plane (except with negative energies, which have to be excluded). Thus we see that a metastable isobar with charge 2 and energy greater than 1 exists, which decays exceedingly rapidly. For practical purposes, this state can be considered as free. Furthermore, a metastable state exists for charge 0, with the negative meson being swallowed up by the proton ($k' > 0$); and also the reverse process, with the negative meson emitted by the neutron ($k' < 0$). Such states are likely to occur in a theory where particles can be emitted and absorbed. This example is given as an illustration of the general theorem, but in view of the preliminary character of the theory of damping the results should not be taken as physical facts.

It appears that almost all zeros and poles of $S$ have a simple physical interpretation. Certain regions only are meaningless : for poles the region $W < m$, and for the zeros the part of the imaginary axis $\varkappa > m$.

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March 4.

[1] Several as yet unpublished papers by Heisenberg. A complete account of them is given by Møller, ref. 2.
[2] Møller, *Kgl. Danske Vid. Sels. Math-Fys. Medd.*, **23**, No. 1 (1945); 22, No. 19 (1946); *Nature*, **158**, 403 (1946).
[3] Heitler and Hu, *Proc. Roy. Irish Acad.*, in the press.

## Units in Photo-Electric Absorptiometry

Koch and Kaplan's criticism[1] of the $E$ (1 per cent, 1 cm.) value does not distinguish between absolute and abridged spectrophotometers[2]. The context indicates that only the abridged type (employing light filters) is in question ; yet $E$ (1 per cent, 1 cm.) is an essentially monochromatic convention that strictly applies to absolute instruments only, and that pertains not to colorimetry but photometry. Moreover, $E$ (1 per cent, 1 cm.) is merely a standard expression that does not carry the implication that one must measure the optical density of a 1 per cent solution in a 1 cm. cell any more than a determination of the coefficient of expansion calls for measurements on a 1 cm. length of material heated through 1° C.

The inherent difficulties of abridged spectrophotometry have been discussed elsewhere[2]. Briefly, resolution lies in the use of (i) a standard the absorption characteristics of which closely resemble those of the test solution, and (ii) a light filter the peak transmission of which (the band being as narrow as possible) corresponds with the peak of absorption of the standard and test solution. Measurements should never be made on the slopes of absorption curves. Under these conditions good approximations to $E$ (1 per cent, 1 cm.) values can be derived.

Koch and Kaplan rightly recognize that measurements should invariably be made at approximately the same optical density. This principle is, or at least should be, embodied in standard practice, but the density chosen depends on the instrument ; for example, 0·43 is best for the ordinary photo-electric absorptiometer[3], and 1·2 for a photographic spectrometer[4]. No instrument known to us has its maximum sensitivity at the proposed optical density of 0·301 (that is, 50 per cent transmission).

The problem, therefore, reduces to the mode of expression of the absorption, and it seems to us that the well-established $E$ (1 per cent, 1 cm.), obtained by extrapolation from the strength and optical density of the cell solution, has this important advantage over the 'half-value' $W^{50}_{1\,\mathrm{cm.}}$

$$[= (\log 2)/100 \times E\ (1\ \text{per cent, 1 cm.})\ ]:$$

it is directly related to quantity, whereas the latter employs minute decimal fractions inversely related to quantity and consequently difficult to assess rapidly at sight.

Incidentally, may we take this opportunity of pleading for the adoption of "$E$ (1 %, 1 cm.)" in place of "$E^{1\,\%}_{1\,\mathrm{cm.}}$", which is not only inelegant typographically but also introduces an awkward piece of type-setting for the printer.

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N. T. Gridgeman

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March 28.

[1] Koch, W., and Kaplan, D., *Nature*, **159**, 273 (1947).
[2] Taylor, R. J., *Analyst*, **71**, 566 (1946).
[3] Twyman, F., and Lothian, G. F., *Proc. Phys. Soc. (Lond.)*, **46**, 643 (1933).
[4] Edisbury, J. R., *Analyst*, **65**, 484 (1940).

## Luminous Phenomena in Oxygen

Prof. J. Kaplan[1] proposes the name 'active oxygen' for certain luminous phenomena observed by him "just as the name active nitrogen was given to similar phenomena in nitrogen". I write to point out that this is not historically correct. I say so with some confidence, having coined the phrase 'active nitrogen' myself[2]. The full title of the paper cited was "A Chemically Active Modification of Nitrogen, Produced by the Electric Discharge", and in the same paper it was shortened into "active nitrogen".

The chemical activity referred to was the combination with metals such as sodium and mercury, to form nitrides, and with organic materials to form cyanogen compounds.

Striking luminous phenomena often accompany these chemical actions, but it is wrong to regard these effects as the essence of the matter.

As a matter of fact, the number of nitrogen molecules which emit a photon of afterglow light is very small compared with the number which become chemically active. For this reason, I do not think that the afterglow should be regarded as the essential phenomenon of active nitrogen, and I do not think that in the present state of knowledge the term 'active oxygen' should be applied by analogy, when only luminous phenomena are so far known to be involved. This would only cause confusion. I may add that I am trying to compile a clear account of these matters.

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[1] *Nature*, **159**, 673 (1947).
[2] *Proc. Roy. Soc.*, A, **85**, 219 (1911).

## Influence of 2,3-Dimercaptopropanol (*BAL*) on Blood Coagulation

Since the announcement by Peters, Stocken and Thompson[1] of *BAL* as an antidote for lewisite, the compound finds increasing application in the treatment of poisoning due to arsenicals[2], mercury salts[3,4] and organic mercurials[5] in humans and animals. Substances containing —SH groups are known to influence blood coagulation, for example, thiosulphate[6], cysteine[7,8] and glutathione[9]. In preliminary experiments it was observed that *BAL* was more active as an anticoagulant than cysteine. This made desirable a detailed study of the influence of *BAL* on the components of the clotting system.

The —SH compounds were dissolved in Sørensen phosphate buffer $M/15$ to produce $p$H 7·1–7·5, and

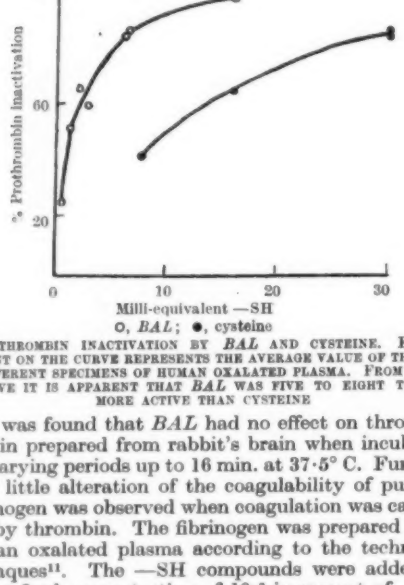
10 per cent of this stock solution was added to human oxalated plasma. The maximum effect on inhibition of coagulation was obtained after 15–30 minutes incubation at 20–28° C. Prothrombin determinations were made according to Quick's technique[10], using as source of thromboplastin either 6 per cent human or 3 per cent rabbit brain suspension and 0·01 *M* calcium chloride.

INFLUENCE OF —SH COMPOUNDS ON THE PROTHROMBIN TIME OF HUMAN OXALATED PLASMA

| Plasma | Glutathione $10^{-4}$ | Cysteine $3\times10^{-4}$ | *BAL* $7\times10^{-5}$ | *BAL* $2{\cdot}9\times10^{-5}$ | Control plasma plus phosphate buffer |
|---|---|---|---|---|---|
| 1 | 16 | 21 | 34 | — | 12·5 |
| 2 | 18 | 25 | 44 | — | 12·5 |
| 3 | 19 | 26 | 35 | — | 12·5 |
| 4 | 29 | — | — | 23 | 17·5 |
| 5 | 19 | — | — | 18 | 13·5 |
| 6 | 19 | — | — | 19 | 13·5 |

The concentrations are given in equivalents of —SH, and the clotting times in seconds

A comparison of the efficacy of *BAL* and cysteine was carried out and the results tabulated on the accompanying graph.




PROTHROMBIN INACTIVATION BY *BAL* AND CYSTEINE. EACH POINT ON THE CURVE REPRESENTS THE AVERAGE VALUE OF THREE DIFFERENT SPECIMENS OF HUMAN OXALATED PLASMA. FROM THE CURVE IT IS APPARENT THAT *BAL* WAS FIVE TO EIGHT TIMES MORE ACTIVE THAN CYSTEINE

It was found that *BAL* had no effect on thromboplastin prepared from rabbit's brain when incubated for varying periods up to 16 min. at 37·5° C. Further, very little alteration of the coagulability of purified fibrinogen was observed when coagulation was carried out by thrombin. The fibrinogen was prepared from human oxalated plasma according to the technique of Jaques[11]. The —SH compounds were added to give a final concentration of $10^{-2}$ in respect of —SH groups. The clotting time of the fibrinogen stock solution was 21 sec. throughout the period of observation, and the highest value found for the experimental mixtures was 24 sec. When oxalated plasma was used instead of purified fibrinogen, no change in the coagulation time was observed when clotting occurred by the addition of thrombin, whereas a similar —SH concentration ($1{\cdot}4\times10^{-3}$) had a marked effect on the prothrombin time. The influence of *BAL* on thrombin was tested by incubating it with thrombin prepared from human oxalated plasma by Eagle's technique[12]. The thrombin solutions were diluted to give convenient clotting times when tested on oxalated plasma, which served as a source of fibrinogen in these tests. A similar ionic strength as well as *p*H was employed. It was observed that thrombin required a considerably higher concentration of the —SH compound even for partial inactivation.

Most of the enzymatic reactions involved in carbohydrate fat and protein metabolism require —SH groups for their activity[13]. From the group of physiologically active substances, insulin appears to be an exception, since it is inactivated by —SH compounds. It has been found that *BAL* combines with arsenicals and metals to form non-toxic cyclic compounds, and it is a strong reducing agent. It also inactivates insulin, possibly by the destruction of the —S—S— groups[14]. *BAL* is more powerful in its detoxicating activities than mono —SH compounds. A comparison of the efficacy of —SH compounds made by Long and Farah[5] in dogs indicated that *BAL* is five to eight times more potent than glutathione or cysteine in protective action against 'Salyrgan'. It is interesting to note that a similar superiority of *BAL* has been observed in prothrombin inactivation. There is no evidence that metal ions except calcium play any part in coagulation, or are part of the prothrombin molecule. It would seem that the inactivation of prothrombin by *BAL* is due to its ability to attack the active centre in the prothrombin molecule, possibly by converting —S—S— groups to —SH radicals.

The action of *BAL* on thrombin is of a different nature. The —SH concentration required to reduce thrombin activity is thirty to forty times greater than that which inactivates prothrombin to a similar extent. In view of the fact that the conversion of fibrinogen to fibrin by thrombin is inhibited by many compounds, including neutral salts, when used in concentrations comparable to those employed in this study, the effect cannot necessarily be considered specific.

The dosage for the treatment of metal poisoning is given as 4–5 mgm. *BAL*/kgm. body-weight. Using a 10 per cent solution in peanut oil, rabbits were injected intramuscularly with 5–7 mgm. *BAL*/kgm. body-weight.

No change in whole blood coagulation time or prothrombin activity could be detected when plasma samples were taken one and two and a half hours after the injection.

Although the effect of *BAL* on coagulation *in vitro* is pronounced, it does not appear likely that this substance will produce hæmorrhagic tendencies *in vivo*.

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## Fibrinolytic Activity of Normal Urine

It has been established that human plasma contains an active fibrinolytic and proteolytic enzyme (plasmin), its inactive precursor (plasminogen), and also an inhibitor (antiplasmin) that normally overneutralizes the enzyme[1,2]. Plasmin and plasminogen are associated with the globulin fraction, antiplasmin with the albumin. Fibrinolytic activity can be induced in plasma by the addition of chloroform, which destroys antiplasmin, or of streptokinase, which activates plasminogen. Activity also occurs spontaneously in human subjects who have suffered surgical operation[3], trauma, fear[4], strenuous exercise, or the injection of adrenalin[5].

The last of these observations revealed the fact that the activity induced by these means disappeared from the circulating blood within a few minutes of the cessation of the stimulus, suggesting that plasmin is rapidly inactivated or eliminated. Among other possibilities its excretion by the kidney was considered, and the consequent examination of the urine by methods already described for plasma fractions[3] has, in fact, demonstrated considerable fibrinolytic activity in all samples examined. This activity existed even when no stimulus had been applied, and though it varied in intensity in the same subject from time to time, and from one subject to another, it was, on the average, four or five times greater than that of active plasmin, complete lysis of fibrin being produced within 24 hours by urine diluted 1/2,000–1/4,000. Though this titre increased considerably after exercise, the amount of urine passed was so much less as compared with control periods of rest that the total active principle excreted was not significantly greater than normal, and it seems improbable that the post-exercise fall in blood-plasmin can be explained by its simple elimination by the kidney.

Nevertheless, in some respects the fibrinolytic agent of urine resembles plasmin. It is not diffusable, being retained by 'Cellophane'. It is precipitated by 50 per cent saturation with ammonium sulphate, full saturation with sodium sulphate, or by bringing the *p*H of the urine to 5·5 after removing all electrolyte by dialysis. It is also precipitated by 50 per cent alcohol or acetone. It will digest fibrinogen, fibrin, albumin and casein, as judged by estimation of acid soluble tyrosine. The *p*H of optimum activity is 7·4, and of maximum heat stability 6·8, these being very close to the corresponding figures for plasmin.

There are, however, points of difference. The urine factor is less heat-labile than plasmin, 5 per cent activity remaining after 30 min. at 80° C., but it is totally destroyed by boiling. The urine factor is inhibited by antiplasmin and soya-bean trypsin inhibitor, and this inhibition is relatively more effective per unit of activity than is the case with plasmin. Plasmin is very strongly adsorbed by fibrin; the urine factor less so.

It is not certain at present, therefore, what relationship the proteolytic enzyme of the plasma bears to the rather similar factor present in the urine. Neither the points of similarity nor of difference are conclusive evidence for or against the two being identical. However, the existence of such an activity of urine is itself of some interest.

Previous observations on the proteolytic activity of urine are few. Loeper and Baumann[6] studied the excretion of 'pepsin' in the urine of normal and pathological subjects, and there is a recent paper on the urinary content of a similar enzyme, with a review of other references, by Farnsworth, Speer and Alt[7]. In view of the clear-cut differences between the properties of pepsin and those of the agent described here, this previous work probably has little bearing on the present observations.

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## Use of Trypsin in the Detection of Incomplete Anti-*Rh* Antibodies

In an attempt to define the properties of the enzyme present in the filtrate of a culture of vibrio cholera, which causes cells sensitized with an 'incomplete' anti-*Rh* antibody to agglutinate[1], cultures of other organisms and pure enzyme preparations have been tested. During this investigation trypsin has been found to cause agglutination of cells sensitized with an 'incomplete' antibody, and also to enhance the specific agglutination of other hæmagglutinins in the absence of any detectable antibody of the 'incomplete' type.

If trypsin is added to the serum or to the cell antigen antibody mixture, its action may be inhibited by the natural trypsin inhibitor present in all sera[2]. This can be overcome by the addition of an excess of the enzyme or removal of the serum inhibitor, or by washing cells already sensitized before exposing them to the trypsin; if this latter method is used, a single washing is sufficient to remove the inhibitor. Test cells may also be incubated with trypsin and, on incubation with sera, show enhancement of agglutination with *iso*agglutinins and immune agglutinins, and agglutination with sera of the 'incomplete' type; and after such treatment are not susceptible to the normal serum inhibitor or to soya bean trypsin inhibitor. With fresh undiluted sera, however, there is also enhancement of rouleau formation, which can be abolished by the addition of saline.

In this investigation the trypsin preparations used have been crystalline trypsin (Plaut Research Laboratory, New Jersey) and *liquor trypsini co.* (Allen and Hanbury). The stock solution of crystalline trypsin has been a 1 per cent solution in *N*/20 hydrochloric acid, and has remained stable for three months. Before use the stock solution is diluted with phosphate buffer (*p*H 7·2) to a concentration of 1 : 400 to 1 : 10,000; and the *liquor trypsini co.* is diluted with buffer to give a final concentration of 1 : 5 of the original solution. With a 1 : 400 solution of crystalline trypsin, complete agglutination of fully sensitized cells occurs within 20 min. With increasing dilution of the enzyme the time of agglutination is lengthened.

As with the enzyme present in the filtrate of vibrio cholera, trypsin appears to act on the surface of the red cell but does not affect any of the known hæmagglutinogen loci. Neither removal of the normal



cell, attempts were made to prevent the onset of

thrombin required a considerably higher concentra-

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trypsin inhibitor from an 'incomplete' serum nor the incubation of inhibitor-free serum with trypsin for up to 30 hr. has changed the type of reaction of the sera from the 'incomplete' to the agglutinating form. After incubation the sera still show the blocking reaction[3], though the 'Coombs' ' test[4] is markedly weakened.

In the detection of incomplete anti-*Rh* antibodies some of the reagents are difficult to obtain or the methods are laborious for routine use. The trypsin method is very simple in execution and only requires a standard pharmaceutical preparation as a reagent. The crystalline trypsin solutions have given positive results in parallel with the Coombs' test with twenty incomplete anti-*D* sera and also with cells sensitized *in vivo* in infants suffering from hæmolytic disease of the newborn.

The full results of these findings, together with considerations of the part they play in agglutination and in the elucidation of the nature of the incomplete antibody, will be published later. We are indebted to Dr. Kunitz for the soya bean trypsin inhibitor and to Dr. A. H. T. Robb-Smith and Dr. R. G. Macfarlane for much help and advice.

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## Succinoxidase Activity of Hepatic Tumours Produced in Rats by Feeding 2-Acetaminofluorene

The succinoxidase content of experimental tumours of various origins, as well as of spontaneous tumours, has been found to be low[1-6]. In agreement with these findings in experiments conducted here, a low succinoxidase activity was found in hepatic tumours produced by feeding *p*-dimethylaminoazobenzene[7]. In a series of experiments, however, the completion of which has been delayed for technical reasons, it was observed that hepatic tumours produced by feeding 2-acetaminofluorene have an exceptional position in so far that the succinoxidase content of these tumours is about the same as, or but very slightly lower than, that of livers from normal rats on the same diet without the carcinogenic compound.

The experiments were carried out on piebald and albino rats weighing about 100 gm. at the beginning of the experiment. They received a diet containing 13 per cent of its caloric value as protein and 30 per cent as fat and 2-acetaminofluorene in a final concentration of 0·07 per cent. The succinoxidase activity was estimated in the Warburg apparatus, in both slices and homogenates. The results obtained are summarized below, the values given being means from six animals; the ranges follow in brackets.

For homogenates in the presence of sodium succinate, oxygen uptake (c.mm.) per 1 mgm. initial dry weight per hour without added cytochrome C was: (*a*) control livers, 15·6 (9·5–19·5); (*b*) liver tissue of animals bearing hepatic tumours, 16·4 (13·8–18·7); (*c*) tumour tissue, 14·9 (9 8–21·8). The succinoxidase activity in the presence of excess cytochrome C was: (*a*) 27·9 (16·2–48·0); (*b*) 30·3 (18·8–44·5); (*c*) 25·2 (13·8–43·8).

For slices the corresponding values for succinoxidase activity per 1 mgm. final dry weight were: (*a*) 38·4 (35·3–45·0); (*b*) 32·6 (28·0–36·7); (*c*) 27·4 (20·3–39·4). The oxygen uptake of the slices without addition of a donor were: (*a*) 9·4 (7·0–11·3); (*b*) 10·1 (8·8–11·3); (*c*) 9·2 (4·5–12·5).

Histologically the tumours were solid hepatomas, but each liver contained a small number of cystic and non-cystic cholangiomas. The tumours were multifocal, and metastases in the regional lymph glands and in the lungs were found. The tissue referred to as 'liver' (*b*) showed on microscopical examination usually small nests of neoplastic tissue. Nevertheless, no difference could be established in the oxidative capacity of these livers and normal livers from rats on the same diet without addition of the carcinogen.

The present experiment demonstrates that tumours from a matrix of high succinoxidase activity can retain this capacity in spite of their obvious malignancy.

I wish to express my gratitude to the Sir Halley Stewart Trust for a fellowship held during this work; my thanks are due also to the British Empire Cancer Campaign, the Anna Fuller Fund and the Jane Coffin Childs Memorial Fund for grants made towards the support of the work carried out in the Chester Beatty Research Institute.

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## Enzymic Modification of the Reaction Between Influenza Virus and Susceptible Tissue Cells

The enzyme of *V. choleræ* which destroys the capacity of red cells to agglutinate with viruses of the influenza group[1] closely parallels these viruses in many aspects of its action on the red cell surface[2]. Investigations were, therefore, made to determine whether this receptor-destroying enzyme could alter the reactivity of tissue cells normally susceptible to infection with influenza virus.

Experiments, similar to those of Hirst[3], dealing with the interaction of virus hæmagglutinin and the tissue cell will be reported first. Hirst has found that the cells of the perfused, excised ferret lung rapidly adsorb influenza virus hæmagglutinin, and after a short period spontaneously release it in essentially the same way as do red cells. In the present work, the behaviour of virus hæmagglutinin was studied in the allantoic cavity of the chick embryo using eggs previously treated with the receptor-destroying enzyme as well as untreated eggs. Formalin, sufficient to kill the embryo within two hours, was administered together with the virus.

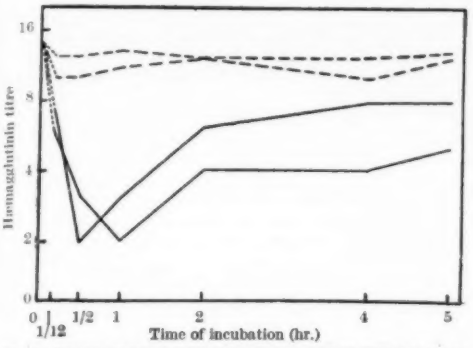


Fig. 1. Graph of virus hæmagglutinin titre in the allantoic cavity of formalinized eggs following pre-treatment with active agar filtrate (receptor-destroying enzyme) (duplicate eggs) – – – – –; boiled agar filtrate (duplicate eggs) ———. Titre of virus dilution injected = 14

The allantoic cavity of a 13-day old embryo was drained, refilled with 5 ml. of saline containing the receptor-destroying enzyme, and the egg slowly rotated for 30 min. at 35° C. in a mechanical device. The fluid was again removed, and a further 5 ml. of saline containing 0·5 per cent formalin and approximately twenty agglutinating doses of swine influenza virus were injected. Samples of fluid taken at intervals over a period of four to five hours at 35° C. were titrated for hæmagglutinin content in the presence of 1 per cent sodium citrate at 4° C. in order to minimize destruction of the receptors of the indicator red cells by residual receptor-destroying enzyme. Control eggs received an initial treatment with saline or with the enzyme inactivated by boiling.

Fig. 1 expresses graphically the results of an experiment in which eggs were treated with a 1 : 10 dilution of crude receptor-destroying enzyme in the form of a Seitz filtrate prepared from soft agar cultures of *V. choleræ* and heated at 55° C. for 40 min. in the presence of excess calcium chloride[4]. Essentially similar results were obtained using the enzyme purified by elution from red cells[4], while the graphs for the eggs receiving boiled agar filtrate are similar to those of eggs receiving pre-treatment with saline only. It will be seen that in the control eggs there is rapid adsorption of virus followed by liberation after a period of three to four hours. Pre-treatment with the receptor-destroying enzyme prevents this adsorption.

Following this evidence of interference with adsorption of virus hæmagglutinin on the susceptible

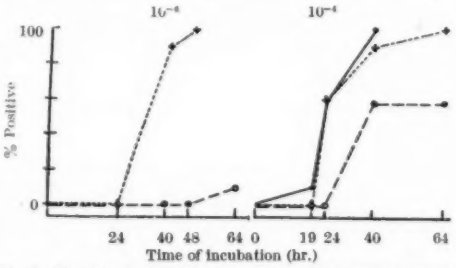


Fig. 2. Effect of receptor-destroying enzyme on infection in the allantoic cavity with virus $10^{-4}$ (ten 50 per cent infective doses) and $10^{-4}$. The percentage of surviving embryos giving positive hæmagglutination is shown for eggs receiving a prior injection of active agar filtrate (receptor-destroying enzyme) – – – – – –; boiled agar filtrate ——; saline .....

cell, attempts were made to prevent the onset of infection in the allantoic cavity of living chick embryos. The receptor-destroying enzyme was administered 30 min. prior to inoculation with swine influenza virus. As evidenced by the experiment illustrated in Fig. 2, administration of 0·5 ml. of agar culture filtrate brought about a highly significant reduction in the percentage of infections, whereas embryos receiving boiled agar filtrate reacted in the same way as did normal embryos. Tests with the enzyme eluted from red cells gave similar results.

These experiments, which are being continued and will be more fully reported elsewhere, lend support to Hirst's hypothesis[3] that enzymic destruction of a specific receptor substance may be a necessary step in the process of cellular infection by influenza virus. In addition, they provide further justification for the use of the red cell as a model in the study of the reaction between virus and the susceptible tissue cell.

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## Pulmonary Œdema and the Spleen

While investigating the pharmacological properties of 2-thio-5-methyl-uracil (thio-thymine), it was noticed that this compound could be given intramuscularly to splenectomized rabbits in a dosage of 100 mgm./kgm. without ill effect, but that a similar dosage when given to normal rabbits invariably produced death from pulmonary œdema; thus, with normal rabbits, 6/6 dead in 5 days; with splenectomized rabbits, 0/6 dead after two months, and similar rabbits sacrificed two–three days after injection showed no macroscopic or microscopic signs of pulmonary œdema.

It is well known that other anti-thyroid agents (for example, phenylthiourea, thiourea and thiouracil[1,2,3]) in acutely toxic doses cause a rapidly fatal pulmonary œdema, but the fact that the spleen is necessary for the production of this œdema has not previously been noted in the literature.

The phenomenon was further investigated by making acid-aqueous (1–3 per cent acetic acid) extracts of hog and beast spleens, suspending 1 gm. thio-thymine in each 10 c.c. of the filtered extracts for six hours at 37° C., and then injecting intramuscularly the thio-thymine-splenic extract mixture (in a dosage corresponding to 100 mgm./kgm. thio-thymine) into splenectomized rabbits. These rabbits all (3/3) died from massive pulmonary œdema. The splenic extracts alone when injected into normal or splenectomized rabbits produced no obvious effects.

Further, the aqueous splenic extracts were precipitated with 7 volumes of 70 per cent alcohol, filtered, the filtrate vacuum-dried and the dried powder redissolved in water. Thio-thymine was then suspended (1 gm. per 10 c.c.) in this deproteinized splenic extract for six hours at 37° C. and the mixture finally injected intramuscularly into splenectomized rabbits, in a dosage corresponding to 100 mgm./kgm. thio-thymine. Again, all the rabbits (3/3) died with pulmonary œdema, whereas the deproteinized ex-



observed by Gregory and Purvis[2] and Purvis[3] with

tissue of animals bearing hepatic tumours, (13·8–18·7); (c) tumour tissue, 14·9 (9 8–21·8). The 16·4

to kill the embryo within two hours, was administered together with the virus.



tracts alone were without effect when injected into control normal and splenectomized rabbits.

The dried precipitate from the alcoholic precipitation of the splenic extracts was next dissolved in water and mixed with thio-thymine at 37° C. for six hours. The mixture was then injected as before into splenectomized rabbits. 1/3 rabbits died from pulmonary œdema: the precipitate alone had no effect when injected into a control group of rabbits.

Landgrebe and Morgan[4] have noted that non-fatal doses of thiourea and thiouracil protect rats from a subsequent normally lethal dosage of thiourea. We have observed a similar effect here, in that splenectomized rabbits which have survived injection of thio-thymine do not succumb to, or show any evidence of, pulmonary œdema after injection of the thio-thymine-splenic extract mixtures.

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## Cultivation of Rabies Virus *in vitro*

I have reported[1] that rabies virus can multiply *in vitro* in a cell-free medium containing steamed sheep-brain extract, sheep serum, glycine and peptone. The effect of the addition of certain amino-acids and accessory factors on the growth of the virus in this medium has been investigated.

Addition of tryptophan in a concentration of 2 mgm. per 100 ml. of the medium showed a stimulating effect on the growth of the virus, the concentration obtained in cultures containing tryptophan being 25 million M.L.D. per ml. as against 10 million M.L.D. per ml. obtained without it. Higher concentrations of tryptophan up to 20 mgm. per 100 ml. of the medium did not yield better results.

The effect of the addition of thiamine hydrochloride, pyridoxine hydrochloride, calcium pantothenate, nicotinic acid, riboflavin and biotin was investigated. All these accessory factors, excepting biotin, were added in a concentration of 2 μgm. per ml. of the medium. The sample of biotin available (its exact potency was not known) was diluted 1 in 10, and 0·2 ml. added per 100 ml. of the medium. The effect of these factors when added to the cultures individually and collectively was investigated.

Concentrations of virus obtained in cultures containing biotin was 100 million, with thiamine hydrochloride 75 million, with pyridoxine hydrochloride 75 million, with calcium pantothenate 75 million, with nicotinic acid 50 million and with riboflavin 50 million M.L.D. per ml. The initial concentration of virus in cultures before incubation was 50,000 M.L.D. per ml. These findings would appear to show that each of the factors tested had marked growth-promoting properties, and that biotin, thiamine hydrochloride, pyridoxine hydrochloride and calcium pantothenate were the most effective.

With the addition of tryptophan, plus all the above factors, it was possible to dispense with the use of steamed sheep-brain extract. Concentrations as high as 5,000 million M.L.D. per ml. were obtained with a medium containing 2·5 per cent glycine, 2 per cent sheep serum, 0·15 per cent peptone, 2 mgm. per cent tryptophan, 2 μgm. per ml. of each of thiamine hydrochloride, pyridoxine hydrochloride, calcium pantothenate, nicotinic acid and riboflavin, together with 0·2 ml. per 100 ml. of biotin solution. This represents about 3,000 times the concentration of virus ordinarily obtained in the brains of infected sheep used in the manufacture of antirabic vaccine.

Comparative tests carried out under aerobic, partially anaerobic and strict anaerobic conditions showed that the concentration of virus obtained in cultures incubated under strict anaerobic conditions was higher than that obtained when cultures were incubated under aerobic or partially anaerobic conditions.

Attempts were made to cultivate rabies virus in a cell-free medium containing 5 per cent glycine, 0·3 per cent peptone and 4 per cent sheep serum in distilled water. The virus inoculum consisted of the filtrate obtained by passing through a Sterimat F.C.B. pad the supernatant liquid from a centrifugalized 20 per cent suspension of fixed virus sheep brain. This was done in order to eliminate the possibility that the 'seed' might contain intact cells which may be responsible for the multiplication of the virus. One part of the virus inoculum was added to one part of the above medium, so that the final concentration of the various constituents was the same as that employed in previous experiments. The proportion of tryptophan and the other accessory factors was kept constant. The virus content of the culture before incubation was 100,000 M.L.D. per ml. After 24 hours incubation under anaerobic conditions, it increased to 2,500 million M.L.D. per ml.

It was also found possible to subculture the virus *in vitro* in this medium, provided 20 per cent steamed normal sheep-brain extract was added to it in quantities equal to the virus inoculum used as the 'seed'.

Successful cultivation of the etiological agent of rabies in a cell-free medium indicates that it is not a virus in the accepted sense of the term. This finding lends further support to earlier evidence I have obtained[2] that an agent other than a virus may be connected with the etiology of rabies.

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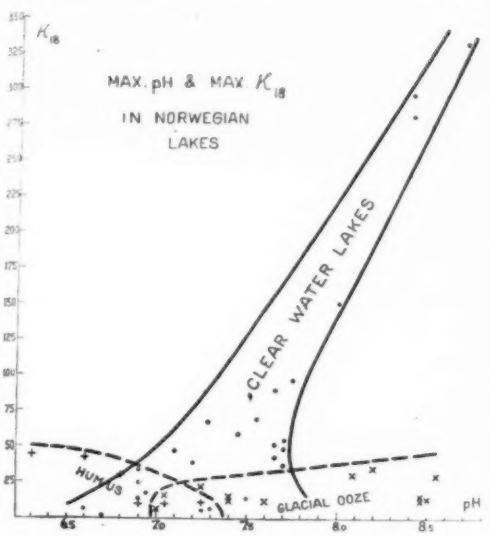
## Correlation Between $\varkappa_{18}$ and *p*H in Lakes

There is a definite relation between specific conductivity ($\varkappa_{18} = n \times 10^{-6}$) and active reaction (expressed as *p*H, and indicating the concentration of hydroxonium ($H_3O^+$) ions) in lake waters. Within a single lake these values vary inversely, which really means that the concentrations of electrolytes and $H_3O^+$-ions move together. Biological processes deplete surface waters of carbon dioxide and dissolved salts. There is a corresponding increase in the deep, where dead organisms sinking down from the fertile, sunlit surface ('trophogenic' zone) disintegrate in the bottom waters ('tropholytic' zone). From lake to lake there is, however, a positive correlation between *p*H and $\varkappa_{18}$.




On the diagram are plotted a large number of data from various lakes in Norway, each point representing one lake. The observations are of the maxima found in each lake, irrespective of the time when the observation was made, or the depth from which the sample was collected. Thus a $x_{18}$-value from the deep in autumn may be paired with a *p*H from surface waters in early summer. Clear-water lakes are indicated by dots; humic waters by crosses; glacial waters by crosses. From several lakes there are series from all depths, extending over one year. The lines of delimitation only refer to the data actually in the diagram, and with additional observations will certainly have to be re-drawn.

The correlation is a close one in all clear-water lakes, especially as soon as there is present an appreciable amount of electrolytes acting as buffers. Only with very low salt concentrations is there a wider range in *p*H, as a little free carbonic acid then suffices to change the reaction appreciably.

Very different are the brown water lakes, where stronger acids may cause a low *p*H, even when there is a relatively high concentration of electrolytes.

Lakes with suspended ooze from glacial melt-water frequently have a disproportionately high *p*H.

This may be due to an adsorption of hydroxonium ions to clay particles of colloidal size, perhaps also to alkali dissolved from freshly ground rock particles.

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March 22.

## Vernalization of Excised Mustard Embryo

IN contrast to vernalized wheat and rye, vernalized unsplit mustard seed does not become devernalized under high temperature[1]. Experiments were undertaken with mustard *T.*102 to find out whether (i) embryos excised from dried vernalized unsplit seeds would produce vernalized plants; and (ii) whether the effects of chilling excised embryos of mustard in different media would be similar to those observed by Gregory and Purvis[2] and Purvis[3] with embryos of winter rye.

Embryos excised from control and vernalized unsplit seeds of mustard *T.*102 (dried and stored at room temperature for thirteen months) were thoroughly washed in glass-distilled water and were sown in pots on April 14, 1946. Control and vernalized whole seeds were also sown on the same date. Plants from embryos showed longer vegetative periods than corresponding plants from whole seeds on account of the lack of cotyledonary leaves in embryo plants. Similar prolongation of the vegetative periods occurred in seedlings (alike control and vernalized) when the cotyledonary leaves were amputated soon after their emergence. Plants from vernalized seeds flowered 13·5 days earlier than plants from control seeds. Plants from embryos excised from dried vernalized seeds flowered 12·5 days earlier than plants from control embryos. This proves that the embryos of vernalized unsplit mustard seeds will retain the induced vernalization for more than a year at least.

In this experiment sterile glassware and solutions were employed, and instead of the usual agar slant in test tubes, small Petri dishes containing a layer of finely powdered 'Pyrex' glass were used for chilling excised mustard embryos. After thorough washing in glass-distilled water, thirty embryos were placed in each of the Petri dishes containing: (1) Purvis'[3] modification of White's nutrient solution plus 2 per cent sucrose; (2) nutrient solution only; and (3) glass-distilled water. Three similar sets of Petri dishes with thirty embryos each were put in the chilling cabinet (2°–4° C.) on appropriate dates so that embryos chilled in the different media for one, two and three weeks were ready for sowing in pots, containing finely sifted sterile garden soil, on April 27, 1946. Intact seeds were also chilled in the same cabinet for one, two and three weeks, and were also sown on the same date, along with control embryos, and seeds germinated at room temperature for three days. The observed number of days from sowing to the opening of the first flowers is given in the accompanying table.

AVERAGE VEGETATIVE PERIODS (DAYS) OF PLANTS FROM CONTROL AND VERNALIZED EMBRYOS AND SEEDS OF MUSTARD *T.*102. (1) NUTRIENT WITH 2 PER CENT SUCROSE; (2) NUTRIENT ONLY; (3) GLASS-DISTILLED WATER. NUMBER OF PLANTS GIVEN IN BRACKETS

| | Embryos Veg. period | Earliness (per cent) | Seeds Veg. period | Earliness (per cent) |
|---|---|---|---|---|
| Control | | | | |
| (1) | Embryos discarded on account of infection | | | |
| (2) | 56·17±0·63 (17) | | | |
| (3) | 56·15±1·01 (13) | | 41·10±1·35 (19) | |
| Chilled: | | | | |
| One week | | | | |
| (1) | 42·70±1·23 (10) | 24 | | |
| (2) | 39·64±0·36 (25) | 29 | | |
| (3) | 40·75±0·52 (24) | 25 | 34·13±1·07 (23) | 17 |
| Two weeks | | | | |
| (1) | 36·04±0·58 (23) | 35 | | |
| (2) | 37·34±0·68 (23) | 33 | | |
| (3) | 39·22±0·64 (22) | 32 | 29·70±0·50 (17) | 28 |
| Three weeks | | | | |
| (1) | 36·56±0·72 (16) | 35 | | |
| (2) | 36·00±0·31 (12) | 36 | | |
| (3) | 36·76±0·58 (13) | 35 | 27·00±0·54 (25) | 34 |

From the table it will be seen that embryos chilled for different periods and in different media produced plants which flowered significantly earlier than plants from control embryos. Thus, like the endosperms of monocotyledons such as wheat and rye, the cotyledons of mustard seeds are not involved in the processes of vernalization. But unlike excised embryos of rye, which according to Gregory and Ropp[4] and Purvis[3] require addition of sucrose in



## THE NEW POSITION OF THE

mittees for England, Scotland and Wales respectively, consisting partly of commissioners and their officers

steamed sheep-brain extract. Concentrations as high as 5,000 million M.L.D. per ml. were obtained with a

lake there is, however, a positive correlation between *p*H and $\varkappa_{18}$.



the medium to induce maximum vernalization, mustard embryos can be maximally vernalized even in glass-distilled water. Purvis[3] has observed that excised embryo of rye, compared to the whole grain, requires longer duration of chilling to induce any acceleration of flowering. In the case of embryos of mustard *T*.102, however, the earliness in flowering (on percentage basis) induced by chilling for one and two weeks was greater in plants from embryos than plants from intact seeds.

A detailed report of this investigation, which is being financed by the Imperial Council of Agricultural Research, New Delhi, is being published elsewhere.

B. Sen
S. C. Chakravarti

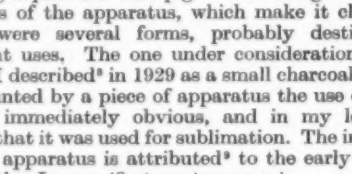
Vivekananda Laboratory,
Almora, India.

[1] Sen, B., and Chakravarti, S. C., *Nature*, **157**, 266 (1946).
[2] Gregory, F. G., and Purvis, O. N., *Ann. Bot.*, **2**, 237 (1938).
[3] Purvis, O. N., *Ann. Bot.*, **8**, 285 (1944).
[4] Gregory, F. G., and de Ropp, *Nature*, **142**, 481 (1938).

## The *Kerotakis* Apparatus

Some interest has been taken in the summary of my Royal Institution lectures[1], and Dr. E. C. Stathis, of the University of Athens, has directed attention to a paper[2] by Prof. K. Zenghelis, of that University, on the *kerotakis* apparatus. Hoefer[3], who reproduced a diagram of it from a Paris manuscript[4], which[5] is copied from the old Venice manuscript[6], called it a '*bain-Marie à kérotakis*', explaining that it was not a water bath (as this name would suggest) but a sand- or ash-bath. The same name is used by Berthelot[7], who, however, gives a more adequate description of the apparatus, and in particular indicates that the name comes from that of the triangular palette used by painters in encaustic for keeping liquid the wax pigments. He gives several pictures of the apparatus, which make it clear that there were several forms, probably destined for different uses. The one under consideration is that which I described[8] in 1929 as a small charcoal brazier, surmounted by a piece of apparatus the use of which is not immediately obvious, and in my lecture I stated that it was used for sublimation. The invention of this apparatus is attributed[9] to the early chemist Maria the Jewess (first century A.D.).

Prof. Zenghelis points out that, since the part of the apparatus above the hot plate is described as an inverted clay pot (φιάλη)[10] luted to the plate, the effects of heat on the materials inside could not be seen; and since the plate is shown in some representations[11] as projecting beyond the pot, he suggests that the ends served to support substances which by their fusion, evaporation or sublimation indicated the temperature inside the pot. Such a method of measuring temperature is still in use in the Seger cones put into pottery furnaces, and, it may be added, in preparations which change colour at definite temperatures and frequently appear in modern patents[12]. The *kerotakis* thus served as a kind of thermometer.




The correctness of this suggestion seems to be supported by a drawing which has not, so far as I am aware, been published. I give a sketch of this which I made in 1924 from a Paris manuscript[13]. It will be seen that there is a line joining the words φαρμακον κηροτακης [*sic*], that is, the materials Prof. Zenghelis thinks were used, with the edge of the plate, where he says they were placed.

There were, as I pointed out in my lecture, rival schools of chemists, the one whose teachings are mostly reproduced in the extant manuscripts being that of Demokritos. Another school seems to have followed Hermes. The commentator Olumpiodoros[14] quotes Agathodaimon as saying, from Hermes: "let it burn before the furnace (ἀπέναντι τῆς καμίνου) with the bark-like pieces of the red kobathia (κωβαθία) [= red arsenic sulphide, $As_2S_2$]. For the smoke of the kobathia, being white [= $As_2O_3$], whitens bodies [= metals such as copper]." This is the method used with such ill success by Neilos (see my lecture), who used a common fireplace instead of the refined *kerotakis* apparatus invented by Maria, of the rival school.

Interest in experiments and apparatus seems to have come into early chemistry from a Jewish source. It was foreign to Greek science; Aristoteles and Theophrastos were excellent at description, and in biology, which until recently was purely observational and descriptive, and hence their accounts seem so modern. They had little or no interest in experiment, and in Greek tradition apparatus was, apart from engines of war, almost entirely confined to toys, which reached a climax in the Byzantine period. To the two streams of Greek tradition, descriptive-biological treatment, and superstitious works such as the lapidaries and bestiaries, a third was added in the earliest chemistry, and this one, characterized by an interest in experiment and in the devising of apparatus, is uniformly ascribed to a Jewish source. Even if Wellmann's[15] thesis of an Essene origin is not accepted, his general theory seems to be plausible. I propose to develop this line of thought in detail elsewhere[16].

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[1] *Nature*, **159**, 81 (1947).
[2] Πρακτικὰ τῆς Ἀκαδημίας Ἀθηνῶν, **5**, 127 (1930); I have used a reprint kindly sent by Dr. Stathis.
[3] "Histoire de la Chimie", **1**, 284 (Paris, 1866).
[4] *BN* 2249 grec.
[5] Berthelot, "Collection des anciens alchimistes grecs", **1**, 129 (Paris, 1887–88).
[6] Marcianus, 299, xii cent.
[7] *Op. cit.*, 148.
[8] "Everyday Chemistry", Fig. 65D, 68 (London, 1929); from *BN* 2325 grec, f. 84 (xiii cent.).
[9] Berthelot, *op. cit.*, **2**, 238; Zosimos quoting Agathodaimon.
[10] This name was also used in the manuscripts for a flask or phial, the latter being so labelled in the drawings.
[11] Marcianus 299, f. 196 = Berthelot, *op. cit.* **1**, 148, Fig. 24; already in Hoefer, *op. cit.*, from Paris 2249, f.102*v* (not "fol. 2 verso", as he says).
[12] For example, I.G. Farben-Ind., French Pat. 922308 (1937); see Tyte, *Proc. Inst. Mech. Eng.*, **152**, 226 (1945).
[13] *BN* 2249, f.103.
[14] Berthelot, *op. cit.*, **2**, 84; for a collection of statements of Hermes in the chemical manuscripts, see Festugière, A. J., "La Révélation d'Hermès Trismégiste", **1**, 240f. (Paris, 1944).
[15] Wellmann, M., "Die Φυσικά des Bolos Demokritos und der Magier Anaxilaos aus Larissa", *Abhl. Preuss. Akad. Wiss., phil.-hist. Kl.*, 1921, No. iv; Festugière, *op. cit.*, p. 197, thinks the correct name is 'Bolos the Demokritan', and that he may be the same as Demokritos the alchemist; I think the latter is doubtful.
[16] The relation to the conjuring tricks described by Hippolytos and the Jewish Gnostic, Markos, will also be discussed. Most of the professional magicians of the period seem to have been Jews.

# THE NEW POSITION OF THE FORESTRY COMMISSION

By Prof. E. P. STEBBING
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IN *Nature* of March 17, 1945, the work of the Forestry Commission during its first twenty-five years was considered. The twenty-sixth annual report, for the year ending September 30, 1945, marks the beginning of a new phase. The report deals with the operations carried out on a more or less much diminished scale which had appertained during the war years. The total area planted by the Commission to the end of September 1945 was 469,000 acres, the total area controlled being 1,364,000 acres. The interest of the report lies in the details given on the future forest policy of Britain. Within the last thirty-five years the country has, on two occasions, for a period of years been dependent mainly on its own supplies of timber, of which in normal times of peace some 10,000,000 tons were imported annually. The two wars caused great inroads to be made on the privately owned woods of the island, for these had to supply the main bulk of the country's requirements; and the fellings—50 million cubic feet—were much heavier during the Second World War than in the First. The new State forests, the oldest but twenty years old at the outbreak of war, could supply only pit wood, from thinnings made in the oldest of the Commission areas. According to old-time accepted thinning theories in Conifers, mainly of German origin, there would have been little or nothing to come from these young British woods of twenty-five years of age and less. But investigation and observation, coupled with practice, have already demonstrated what had been expected, that in the exceptional moist and equable climate of Britain, the growth of some of the exotic Conifers surpasses that of the Conifers of Western Europe; hence earlier thinning is possible, though present experience is insufficient to lay down a rule in the matter.

The report notes that the year was a period of transition in national affairs, and the same in the Commission itself. The Forestry Act of 1945, which received Royal assent in June, changed the constitutional status of the Commission, which had been established under the Forestry Act of 1919. The progression of the new forestry work, the War and the heavy fellings in the privately owned woods, necessitated some changes in policy and administration. Up to then, the Commission had been an independent body subject only to the Treasury, which held the purse strings. In February 1945, it was announced in the House of Commons that in future the Minister for Agriculture, England and Wales, and the Secretary of State for Scotland would be responsible for forestry and forest policy in Great Britain, the Forestry Commission being retained as an advisory body with executive functions. Closer relations were to be made between the Agricultural Departments and the Commission. In practice this means that the officers serving in the Forestry Commission, of all categories, now form one of the Service Departments of the State for which a Cabinet Minister is responsible, and that forestry matters cropping up in the House of Commons will now have a Minister instead of a private member of the House, as before, to reply for and back up the forest policy already laid down. Ten Commissioners are to be maintained, and they are required to appoint committees for England, Scotland and Wales respectively, consisting partly of commissioners and their officers and partly of other persons. The commissioners will, in the words of the report, "devolve on these Committees such functions as they think fit". The new arrangement will undoubtedly make for forestry progress—the danger is that the latter will be clogged by the redundancy of committees and sub-committees which appear to be springing up all over Britain. It is difficult to foresee how these will make for either efficiency or rapidity of work, both of which are eminently desirable: the more so that the newly sanctioned forestry programme envisages the afforestation or replanting of 365,000 acres at a cost to the State of £20,000,000 spread over five years—a piece of work which will be watched with eagerness and will necessitate some rapid moving.

One outcome of the new trend given to the forest policy question in Britain is to be found in the much discussed 'Dedication of Woodlands' scheme, which in its first enunciation appeared to place all privately owned woodlands under the Forestry Commission. The first proposals were modified. The purpose of the scheme is to encourage correct management in private woods. This step is said to have become necessary in the interests of national security, because the reserves of standing timber were again greatly depleted during the War, and also because the area of land suitable and available for timber production in Great Britain is limited. The first of these contentions appears to ignore the fact that, however badly British privately owned woodlands may have been managed in the past, they did provide nearly 50 million cubic feet of timber for the War, for the growth of which the State, that is, the ordinary public, had paid nothing. But the very fact that so large a proportion of the woods of the country have been swept away makes their replacement a matter of the first importance, especially as the acres they occupied contain forest soils, a valuable planting asset which is absent on the large tracts of bare land which the Commission is engaged in afforesting. The principles underlying the scheme are: "(1) That the rehabilitation of Woodlands must proceed with both certainty and rapidity. (2) That all planting, and natural regeneration acceptable instead of replanting, must be properly looked after up to the stage of satisfactory establishment. (3) In every case the Owner must make an early decision as to whether he is prepared to proceed with the work of rehabilitation. (4) If an Owner is so prepared and can give satisfactory assurances, he is deserving of financial assistance from the State. (5) When no satisfactory assurances are forthcoming within a stated period, the State should acquire the land. (6) That the war-time system of felling licences must continue until the reserves of standing timber can be adjudged satisfactory. (7) That some degree of control of the Sylviculture of private woodlands is necessary."

The basis of the scheme, in which the State undertakes to provide certain financial assistance, is that all woodlands in Britain judged to be suitable and necessary for timber production should either be dedicated to that purpose by the owner or acquired by the State. Dedication would run with the land and would be unaffected by changes of ownership. A covenant of dedication will be entered into by which both the State and the owner undertake the respective obligations agreed upon. The covenant would provide for arbitration in the event of disagreement.



# INTERNATIONAL UNION OF

The secretary for the present period is Prof. J. M.

professional magicians of the period seem to have been Jews.



# NEW YORK ACADEMY OF MEDICINE

## CENTENARY AWARDS

THE end of the centenary celebration of the New York Academy of Medicine (see *Nature*, April 12, p. 494) was marked by a Convocation Meeting held on April 24. The Medal of the Academy was awarded to Dr. James Alexander Miller, an authority on tuberculosis, who has been associated with the Academy for many years and in 1937 was its president. This medal was established in 1930 by Dr. Samuel McCullagh, to be awarded periodically to a distinguished medical scientist in recognition of outstanding service to humanity.

The following were elected honorary fellows of the Academy:

Dr. J. B. Collip, director of the Research Institute of Endocrinology of McGill University, known for his work on blood and tissue chemistry, who was largely responsible for the chemical isolation of insulin; Dr. Robert Debré, professor in the Paris Faculty of Medicine, author of outstanding works in the field of pediatrics and public health; Sir John Fraser, principal of the University of Edinburgh and regius professor of clinical surgery in the University; Dr. E. W. Goodpasture, professor of pathology and dean of the School of Medicine, Vanderbilt University, who has done outstanding work on virus diseases; Dr. Evert Gorter, professor of pediatrics, University of Ghent, known for his publications on the diseases of children; Prof. Einar Hammarsten, professor of pharmacology, Karolinska Institutet, Stockholm; Dr. A. V. Hill, Foulerton research professor of the Royal Society; Dr. G. M. Holmes, consulting physician to the National Hospital of Nervous Diseases, and president of the second International Neurological Congress; Dr. B. A. Houssay, president of the Argentine Society of Biology and of the Biological Section of the Argentine National Academy of Medicine, who has made valuable contributions to our knowledge of the hypophysis and pancreatic secretion; Sir William Wilson Jameson, chief medical officer of the Ministry of Health and Ministry of Education; Dr. Otto Loewi, known for work in the field of nerve physiology and on the chemical transmission of nerve impulses; Dr. T. Madsen, formerly director of the Laboratory of the State Serum Institute in Denmark, known for outstanding work on serology and epidemiology and public health; Dr. M. Martinez-Báez, head of the Institute of Tropical Diseases and professor in the School of Hygiene, National University of Mexico; Dr. L. A. Orbeli, director of the Pavlov Institute in Leningrad, known for his work on the physiology of the nervous system; Sir John Boyd Orr, director-general of the United Nations Food and Agriculture Organisation; Dr. A. N. Richards, chairman of the Committee on Medical Research, Office of Scientific Research and Development, whose work in recent years has dealt with the function of the kidney; Prof. J. A. Ryle, professor of social medicine and head of the Institute of Social Medicine, University of Oxford; Dr. René Sand, professor of social medicine, University of Brussels; Dr. H. E. Sigerist, director of the Institute of the History of Medicine, Johns Hopkins University, known for his work on the history of medicine; Dr. A. Stampar, rector and professor of public health and social medicine, University of Zagreb; Dr. A. Tiselius, professor of biochemistry, University of Uppsala, who has made outstanding contributions to our knowledge of biologically important substances, and their separation through the development of an apparatus for electrophoresis.

The following were elected corresponding fellows of the Academy:

Dr. C. H. Best, professor of physiology, University of Toronto, co-discoverer of insulin; Dr. E. Braun-Menéndez, physiologist connected with the Institute of Biology and Experimental Medicine in Buenos Aires; Dr. E. B. Chain, lecturer in chemical pathology, University of Oxford; Prof. H. R. Dean, professor of pathology, University of Cambridge; Dr. N. Hamilton Fairley, director of special research, Hospital for Tropical Diseases, London; Sir Alexander Fleming, professor of bacteriology, University of London, known for his work on bacteriology, immunology and chemotherapy, and on penicillin; Sir Howard Florey, professor of pathology, University of Oxford, known for his work on penicillin; Dr. C. Heymans, professor of pharmacology and director of the Institute of Pharmacology and Therapeutics of the University of Ghent, who has worked on the physiology and pharmacology of the cardiovascular and central and peripheral systems and of respiration; Dr. A. Lacassagne, associate director, Pasteur Laboratory, Institute of Radium, University of Paris; Dr. G. Liljestrand, professor of pharmacology and director of the Pharmacological Institute, Karolinska Institutet, Stockholm, known for his work on the physiology and pharmacology of respiration and the circulation; Dr. J. M. Mackintosh, dean and professor of public health, London School of Hygiene and Tropical Medicine, University of London; Dr. F. de P. Miranda, director of the National Institute of Nutrition of the Ministry of Public Health and Assistance, Mexico; Dr. A. L. v. Muralt, professor of physiology and director of the Hallerianum, University of Bern; Dr. J. V. J. Parisot, professor of hygiene and social medicine and director of the Regional Institute of Hygiene, Nancy; Dr. M. Ruiz-Castañeda, director of the Department of Medical Research, General Hospital, Mexico City, known for his work on typhus and Malta fever; Dr. A. v. Szent-Györgyi, director of the Institute of Biochemistry, University of Budapest; Sir Lionel Whitby, regius professor of physic, University of Cambridge, known for work on hæmatological and bacteriological subjects.

Awards were made as follows:

*Bowen-Brooks Scholarships* (eight awards of 500 dollars each). Because of changing conditions, they are being given for continued study in the United States of returning young medical men: William Henry, Joseph F. Hindman, Martin H. Orens, Maurice S. Raben, E. Lawrence Reichel, C. R. Southworth, Stanley Stellar, Joseph R. Wilder.

*Louis Livingston Seaman Award*, for aid in investigation in bacteriology or sanitary science: Dr. James M. Neill, Cornell University Medical College (1,000 dollars); Dr. Arnold W. Pratt, Cornell University Medical College (500 dollars); Dr. A. M. Pappenheimer, New York University College of Medicine (500 dollars); Dr. Samuel Prigal, New York City (500 dollars).

*Edward N. Gibbs Memorial Prize*, given by Mrs. Gibbs and Mrs. Charles Sherrill (daughter): Dr. Stanley E. Bradley, College of Physicians and Surgeons (1,500 dollars).

## INTERNATIONAL UNION OF THEORETICAL AND APPLIED MECHANICS

AT the Sixth International Congress for Applied Mechanics, held at the Sorbonne in Paris, during September 22–28, 1946, the International Congress Committee, under the sponsorship of which these congresses are organised, decided to create a more permanent organisation, in order to provide the possibility of carrying out activities in the interval between the congresses and of entering into co-operation with other international scientific bodies. This permanent organisation adopted the name of "The International Union of Theoretical and Applied Mechanics". In agreement with the policy followed with respect to the international congresses for applied mechanics, the structure of the new Union thus far has been kept as simple as possible; a council has been elected, consisting at present of thirty members, and a secretary has been nominated for carrying out correspondence. The Council is the executive body of the Union; its members are persons actually engaged in scientific work (theoretical or experimental) in mechanics or in related sciences. The number of members of the same nationality must not in general exceed four; in certain cases a few extra members can form part of the Council, without being representatives of a particular country.

It is hoped that national organisations concerned with scientific work in applied mechanics and already in existence in various countries may be willing to enter into relationship with the International Union. The statutes of the latter have therefore been so framed that it will be possible to admit national organisations (or a national union of such, if there are more than one in the same country) as adhering organisations of the International Union. Any such national organisation (or union) can apply to have a representative on the Council. Organisations interested in co-operation with the International Union are invited to communicate with the representatives for their country.

Now that the draft statutes have obtained the required number of votes, the International Union is formally constituted. It will seek admission as an organisation adhering to the International Council of Scientific Unions.

Members of Council are at present: (*Belgium*): L. Baes (Brussels), F. H. van den Dungen (Brussels); (*Bulgaria*): K. Popoff (Sofia); (*China*): P. Y. Chou (Peiping), Y. H. Ku (Shanghai); (*Denmark*): J. Nielsen (Copenhagen); (*France*): A. Caquot (Paris), J. Pérès (Paris), H. Villat (Paris); (*Great Britain*): S. Goldstein (Manchester), R. V. Southwell (London), G. I. Taylor (Cambridge); (*Netherlands*): C. B. Biezeno (Delft), J. M. Burgers (Delft), C. Koning (Amsterdam); (*Norway*): J. Solberg (Oslo); (*Poland*): M. T. Huber (Gdańsk-Wrzeszcz); (*Sweden*): W. Weibull (Bofors); (*Switzerland*): J. Ackeret (Zurich), H. Favre (Zurich); (*Turkey*): Kerim Erim (Istanbul); (*United States*): H. L. Dryden (Washington, D.C.), J. C. Hunsaker (Cambridge, Mass.), Th. von Kármán (Pasadena, Cal.), S. P. Timoshenko (Palo Alto, Cal.); (*U.S.S.R.*): S. A. Christianovitch (Moscow), A. N. Kolmogoroff (Moscow), E. L. Nicolai (Leningrad). Extra members are: R. von Mises (Cambridge, Mass., U.S.A.); H. U. Sverdrup (La Jolla, Cal., U.S.A.).

The secretary for the present period is Prof. J. M. Burgers, van Houtenstraat 1, Delft, Holland.

It has been decided to accept the invitation of the Imperial College of Science and Technology, South Kensington, London, S.W.7, to hold the seventh International Congress for Applied Mechanics in its buildings during September 5–12, 1948.

## THE EGYPTIAN ACADEMY OF SCIENCES

THE number of scientific workers in Egypt has increased considerably since the foundation of the Faculty of Science of the Fouad I University at Cairo in 1925. This has been accompanied by the development of a number of societies dealing with various branches of science, among which special mention may be made of the Société Entomologique d'Égypte, with its fine series of *Bulletins* and *Mémoires* dating from 1907. There has arisen also a demand for some institution where scientific specialists could meet and exchange ideas, for the famous Institut d'Égypte, founded by Napoleon, covers too wide a range of interests to meet these requirements. Accordingly, a group of nine Egyptians representing different branches of science met together in 1944 and founded an Egyptian Academy of Sciences, with Prof. Mohamed Khalil Bey as its secretary. The main objects of the new Academy are to stimulate a wider interest in science in general, and lead to more co-operation between men of science and a better co-ordination of their efforts.

The first volume of the *Proceedings* for 1945, published in 1946, has just been received, and comprises six articles dealing with biological subjects. All are written in English, but full abstracts in Arabic are included.

The first article, by the editor, Prof. K. Mansour, is devoted to an account of the Zooxanthellæ, and the food and feeding habits of the Tridacnidæ, in which the author attributes the large size reached by these lamellibranchs to their efficient feeding mechanism, and capacity of sieving huge quantities of water. The following article by Dr. J. J. Mansour-Bek deals with the digestive enzymes of *Tridacna elongata* and *Pinctada vulgaris*. In both papers the views of Prof. C. M. Yonge and others, as to the importance of intra-cellular digestion in these lamellibranchs, are strongly criticized. Prof. Y. S. Sabet describes the reaction of *Citrus mycorrhiza* to manurial treatment, and Z. Ahmed the effect of some environmental conditions on the growth and alkaloidal content of *Hyoscyamus muticus*. The nervous control of melanophores in the Egyptian chameleon is the subject of an interesting communication by Dr. A. M. Farghaly, and finally Dr. H. Said discusses the reaction of cotton, beans and other plants to colchicine treatment.

The difficulties attending publication in a foreign language have resulted in an unduly large number of printer's errors, but these do not affect the general standard of the *Proceedings*. Men of science in other countries will welcome the appearance of this publication and wish the new Academy every success. The *Proceedings* can be obtained either by exchange of corresponding publications, or by subscription (one Egyptian pound per annum). Communications should be addressed to the Hon. Secretary, Dar el Hikma, 42 Kasr Aini Street, Cairo, Egypt. E. HINDLE

# FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

## Monday, June 9

UNIVERSITY COLLEGE, LONDON (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Prof. Kapp: "The Presentation of Technical Information", Second Series, 2: "The Part Played by Psychology in Presentation".*

## Tuesday, June 10

MEDICAL RESEARCH COUNCIL (at the Royal Institution, 21 Albemarle Street, London, W.1), at 5 p.m.—Prof. Robley D. Evans: "Applications of Radio-active Isotopes in Biological Research".*

ROYAL ANTHROPOLOGICAL INSTITUTE (joint meeting with the INTERNATIONAL AFRICAN INSTITUTE, at 21 Bedford Square, London, W.C.1), at 5.30 p.m.—Dr. S. F. Nadel: "Shamanism in the Nuba Mountains".

## Wednesday, June 11

MANCHESTER STATISTICAL SOCIETY (at the Reform Club, King Street, Manchester), at 5 p.m.—Annual General Meeting.

INSTITUTE OF PETROLEUM (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Dr. A. C. Healey and Dr. L. Ivanovszky: "Petroleum Products in the Printing Ink and Allied Industries".

## Thursday, June 12

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. E. B. Verney, F.R.S.: "The Antidiuretic Hormone and the Factors which Determine its Release" (Croonian Lecture).

## Friday, June 13

INSTITUTE OF ECONOMIC ENGINEERING (at Cowdray Hall, 1A Henrietta Place, London, W.1), at 7 p.m.—Mr. R. Cecil Smart: "Research and Expansion in Industry".

## Sunday, June 8—Friday, June 13

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1).—Centenary Celebrations.

## Saturday, June 14

INSTITUTE OF PHYSICS, ELECTRONICS GROUP (in the Fyvie Hall, The Polytechnic, 309 Regent Street, London, W.1), at 2.30 p.m.—Discussion on "Thermionic Emission from Oxide-Coated Cathodes" (to be opened by Dr. F. A. Vick, Mr. D. A. Wright and Mr. A. J. H. Darlaston).

# APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT REGISTRAR—The Secretary, Imperial College of Science and Technology, Prince Consort Road, London, S.W.7 (June 13).

LECTURER IN THE ENGINEERING DEPARTMENT of the County Technical College, Wednesbury—The Director of Education, Dept. F.E., County Education Offices, Stafford (June 14).

CHIEF METALLURGIST (temporary) to take charge of extensive chemical, metallurgical and testing laboratories at the Royal Ordnance Factory, Patricroft, near Manchester—The Ministry of Labour and National Service, Technical and Scientific Register, Room 171, York House, Kingsway, London, W.C.2, quoting F.388/47A (June 14).

CHEMISTS (temporary) IN THE DEPARTMENT OF ATOMIC ENERGY, Springfields Factory, Preston—The Ministry of Labour and National Service, Technical and Scientific Register, Room 171, York House, Kingsway, London, W.C.2, quoting F.389/47A (June 14).

EXPERIMENTAL ASSISTANTS (II and III, temporary) IN THE DEPARTMENT OF ATOMIC ENERGY, Springfields Factory, Preston, under the Ministry of Supply—The Ministry of Labour and National Service, Technical and Scientific Register, Room 171, York House, Kingsway, London, W.C.2, quoting F.390/47A (June 14).

LECTURER IN MATHEMATICS and MECHANICS—The Principal, Willesden Technical College, Denzil Road, London, N.W.10 (June 14).

LECTURER IN PHILOSOPHY in University College, Dundee—The Secretary, The University, St. Andrews (June 15).

SENIOR LECTURER, and a LECTURER, IN NATURAL PHILOSOPHY—The Secretary, The University, Aberdeen (June 20).

SENIOR ASSISTANT IN THE MATHEMATICS DEPARTMENT, a LECTURER IN CHEMISTRY, and a LECTURER IN GEOLOGY AND BIOLOGY—The Principal, Derby Technical College, Normanton Road, Derby (June 21).

LECTURER and an ASSISTANT LECTURER IN ORGANIC CHEMISTRY, and a LECTURER and an ASSISTANT LECTURER IN PHYSICAL CHEMISTRY—The Secretary, King's College, Strand, London, W.C.2 (June 21).

LECTURER IN ENGINEERING at Peterborough Technical College—The Chief Education Officer, Education Offices, Town Hall, Peterborough (June 21).

CHAIR OF PSYCHIATRY—The Secretary, The University, Edmund Street, Birmingham 3 (June 28).

RESEARCH FELLOWSHIP (Organic Chemist to conduct research in problems relating to child health)—The Secretary, Institute of Child Health, Hospital for Sick Children, Great Ormond Street, London, W.C.1 (June 30).

PRINCIPAL SCIENTIFIC OFFICERS: (a) PHYSICIST to lead and direct research in problems of heat transfer in and as the result of fires, and (b) PHYSICAL CHEMIST to take charge of work on various problems of combustion and the suppression of fire by chemical means—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1911 (June 30).

SUPERINTENDING CHEMICAL ENGINEER IN THE CHEMICAL RESEARCH AND DEVELOPMENT DEPARTMENT of the Ministry of Supply—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1902 (June 30).

LECTURER IN AGRICULTURE (Crop Husbandry), and an ASSISTANT LECTURER IN AGRICULTURAL BOTANY—The Registrar, University College of Wales, Aberystwyth (June 30).

LECTURER IN CHEMISTRY AND SOIL SCIENCE, at Trinidad—The Secretary, Imperial College of Tropical Agriculture, Grand Buildings, Trafalgar Square, London, W.C.2 (June 30).

ASSISTANT LECTURER IN GEOLOGY—The Registrar, University College, Cathays Park, Cardiff (June 30).

HEAD OF THE PHARMACY DEPARTMENT—The Principal, Heriot-Watt College, Edinburgh (June 30).

DEPUTY GOVERNMENT CHEMIST in Jamaica—The Director of Recruitment (Colonial Service), 15 Victoria Street, London, S.W.1 (June 30).

ASSISTANT LECTURER, and DEMONSTRATORS (3), IN THE DEPARTMENT OF ANATOMY—The Registrar, University College of South Wales, Cathays Park, Cardiff (June 30).

LECTURER IN MECHANICAL ENGINEERING—The Registrar, Merchant Venturers' Technical College, Unity Street, Bristol 1 (June 30).

PRINCIPAL of the new Technical College to be established at Grantham—The Director of Education, County Offices, Sleaford, Lincs. (June 30).

LECTURER (Grade II) and an ASSISTANT LECTURER (Grade III) IN THE DEPARTMENT OF APPLIED MATHEMATICS—The Registrar, The University, Liverpool (July 1).

SENIOR RESEARCH OFFICER or RESEARCH OFFICER, Section of Meteorological Physics Research, Melbourne—The Secretary, Australian Scientific Research Liaison Office, Australia House, Strand, London, W.C.2, quoting No. 1291 (July 7).

UNIVERSITY LECTURERS and UNIVERSITY DEMONSTRATORS IN ENGINEERING—The Secretary, Appointments Committee, Engineering Laboratory, Cambridge (July 7).

HENRY BELL WORTLEY CHAIR OF METALLURGY—The Registrar, The University, Liverpool (July 7).

PROFESSOR OF MATHEMATICS, a PROFESSOR OF PHYSICS, a SENIOR LECTURER IN MATHEMATICAL PHYSICS, and a SENIOR LECTURER IN PHYSICS, at the University of Otago, Dunedin—The High Commissioner for New Zealand, 415 Strand, London, W.C.2 (July 15).

LECTURER IN BOTANY, a LECTURER IN ZOOLOGY, a LECTURER IN CHEMISTRY, and an ASSISTANT LECTURER IN MATHEMATICS, at the University of Otago, Dunedin—The High Commissioner for New Zealand, 415 Strand, London, W.C.2 (July 31 in New Zealand).

FUEL ENGINEER and ASSISTANT FUEL ENGINEER (male) under the Ministry of Fuel and Power—The Director of Establishments, Ministry of Fuel and Power, 7 Millbank, London, S.W.1 (July 31).

LECTURER IN MECHANICAL ENGINEERING at the Chance Technical College—The Chief Education Officer, 215 High Street, Smethwick.

SCIENCE LECTURER IN THE DEPARTMENT OF BAKERY AND CONFECTIONERY—The Principal, Borough Polytechnic, Borough Road, London, S.E.1.

CROP RECORDER, and an ASSISTANT SEED PRODUCTION OFFICER—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

REGISTRAR—The Principal, Huddersfield Technical College, Huddersfield.

ELECTRONICS TECHNICIAN to undertake development, construction and maintenance work on electronic apparatus for medical use—The House Governor and Secretary, General Infirmary, Leeds.

CHEMISTS (men and women) for temporary appointments in the Chemical Inspection Department, Ministry of Supply—The Ministry of Supply, Est. 5 (B) 2, Room 828, Adelphi, London, W.C.2, quoting Chem/65.

GRADUATE RESEARCH ASSISTANT for experimental work on nuclear physics, mainly by cloud-chamber methods—The Professor of Physics, University College, Aberystwyth.

LECTURER (preferably recent Ph.D.) in field of nuclear physics, in the Department of Physics, Queen's University, Kingston, Canada—Principal R. C. Wallace, 15 Mays Hill Row, Shortlands, Bromley, Kent.

LABORATORY ASSISTANT (bacteriological, Grade B)—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, Berks.

# REPORTS and other PUBLICATIONS

*(not included in the monthly Books Supplement)*

## Great Britain and Ireland

Forestry Commission. Twenty-sixth Annual Report of the Forestry Commissioners for the Year ending September 30th, 1945. Pp. 52. (London: H.M. Stationery Office, 1946.) 9*d*. net. [9]

Forestry Commission. Leaflet No. 4: The Black Pine Beetle (*Hylastes ater*) and other Closely Allied Beetles. Revised edition. Pp. 10. 2*d*. net. Leaflet No. 23: Pit-Props. Revised edition. Pp. 8. 2*d*. net. (London: H.M. Stationery Office, 1946.) [9]

B.C.P.M.A. List of Members and Classified Index of Subjects. Pp. 44. (London: British Chemical Plant Manufacturers' Association, 1946.) [9]

Communications of the Dublin Institute for Advanced Studies. Series A, No. 3: Developments in Quantum Electrodynamics. By Paul A. M. Dirac. Pp. 33. (Dublin: Dublin Institute for Advanced Studies, 1946.) 3*s*. [13]

Anti-Locust Memoir 1: Seasonal Breeding and Migrations of the Desert Locust (*Schistocerca gregaria* Forskål) in Eastern Africa. By Z. Waloff. Pp. 76. (London: Anti-Locust Research Centre, British Museum (Natural History), 1946.) 8*s*. [13]

National Institute of Economic and Social Research. Annual Report, 1945–6. Pp. 24. (London: National Institute of Economic and Social Research, 1946.) [13]

The New Age of Atomics. (New Age Series, No. 2). Pp. 24. (London: Social Science Association, 1947.) 6*d*. [13]

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The publishers are always interested to ★ receive suggestions for additions to this ★ series.

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*(Continued from page iii of Supplement)*

GEOLOGIST

Following publication of the Government's "Plan for the Mechanized Production of Groundnuts in East and Central Africa" (H.M. Stationery Office Cmd. 7030), applications are invited for the post of Junior Geologist for the East African Groundnut Scheme. Duties will include advising on general geological matters, location of deposits of limestone and suitable phosphates, location of water supplies. Candidates should have some practical experience, and the salary offered will be according to age and experience. There are good opportunities for promotion. Conditions of service provide free passages to and from East Africa on appointment and for home leave. Home leave at the rate of five months every 33 to 39 months, with local leave in addition. Provision of housing and basic furniture as soon as this is available. Membership of a contributory provident fund (to which the Managing Agency will contribute an equal amount).

The Geologist appointed will be required to take up his duties in East Africa at the earliest possible date.

Applications, which should give full details of qualifications and experience, should be addressed to United Africa Company (Managing Agency), Ltd., Geologist, R.I.E., Unilever House, London, E.C.4.

APPLICATIONS ARE INVITED FOR THE posts of a Professor of Physics and of a Professor of Chemistry at the Indian Association for the Cultivation of Science in the grade of Rs.800-40-1,000-50-1,250.

Applicants to the post of Professor of Physics should be distinguished physicists having long experience of research in *x*-rays and optics, including Raman effect, and capable of guiding research work in these subjects.

Applicants to the post of Professor of Chemistry should be distinguished chemists with special knowledge of physical chemistry. He will be required to organize and promote research and guide scholars engaged in research work. Experience of research work on high polymers is preferable.

Six copies of applications, together with testimonials, statement of qualifications, age, and list of original publications, with complete reference to the journals in which they have been published, should reach the Registrar, Indian Association for the Cultivation of Science, 210, Bowbazar Street, Calcutta, on or before July 30, 1947. For candidates applying from U.K. or U.S.A., abstracts of applications may be sent by air-mail. Canvassing would be regarded a disqualification.

THE BRITISH COTTON AND WOOL Dyers' Association, Ltd., invite applications for the following positions in their research laboratories:

Chemist to assist in the technological and other aspects of research and development on the dyeing and finishing of textiles; preferably with some experience of wool. Graduate or equivalent qualifications required. Salary according to qualifications and experience.

Assistant Chemist of Inter.B.Sc. standard. Research or textile experience is not essential. Encouragement will be given to continue studies for B.Sc.

Physicist. This post would be suitable for a young graduate, direct from the university or with a few years' experience. The activities of the Association cover a wide range of fibres and processes and lend themselves to an interesting career. Salary according to qualifications, etc.

Technical Officer. The Association requires the services of a person having a good scientific background to assist in abstracting technical literature, in writing reports, and in keeping laboratory records. Knowledge of technical French and German desirable. Salary according to qualifications, etc.

Apply to Research Laboratories, the British Cotton and Wool Dyers' Association, Ltd., 22, Cumberland Street, Manchester, 3.

ASSISTANT CHEMIST REQUIRED FOR production control and research on pharmaceuticals. Applicants should hold the B.Pharm. or equivalent qualifications. Previous experience in the assay of vitamin products by physical methods an advantage. Applications, giving details of qualifications and previous experience, etc., to the General Manager, Gelatin Products, Ltd., Trading Estate, Slough, Bucks.

PHYSICIST WITH EXPERIENCE AND high qualifications in administration, age 39, desires appointment. Initial salary £1,000 per annum. Box P.287, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

FOR SALE, 8 IN. REFLECTING ASTRONomical Telescope on portable stand, 2 Browning Spectroscopes, 2 Mercury Barometers. Apply 3, Alverstone Road, N.W.2.

PHYSICISTS REQUIRED FOR RESEARCH work in several categories, viz.:

(1) Thermionic emission and high vacuum work.
(2) Electronics.
(3) Electrical and magnetic instruments.
(4) Industrial process control.

Applicants should be not more than 25 years old. Experience in one of the above categories is advisable, but not essential. Salary will be according to age and experience, and F.S.S.U. benefits will be available after a probationary period.

The Association's new laboratories are located in South-east London. Apply in writing to the Director and Secretary, the British Scientific Instrument Research Association, 26, Russell Square, London, W.C.1.

APPLICATIONS ARE INVITED FOR A Technical Officer. Duties will comprise advisory work on technical problems of rubber manufacture, co-operation with the research staff in developing laboratory results into industrial practice, and liaison with member firms by visits and otherwise. Applicants must have rubber works' experience and a scientific training, preferably to degree standard in chemistry or physics. Age preferably 30 to 40. Commencing salary between £550 and £750, according to qualifications. The post will carry the benefits of the F.S.S.U. Applications should be sent to the Secretary, R.A.B.R.M., 105, Lansdowne Road, Croydon, on or before July 5, 1947.

A SENIOR CHEMIST (NOT NECESSARILY a graduate) is required for research in the Synthetic and Varnish Department of the laboratory of a well-known N.W. London firm manufacturing aircraft and industrial finishes. Previous experience, with a specialized knowledge of synthetic resins and varnishes and the formulation of finishes therefrom, will be regarded as an essential qualification for the post, and as of more importance than purely academic to an enthusiastic worker, and the salary envisaged is about £600 per annum, but will depend to some extent on age, qualifications, and experience. Applications, giving all relevant details, should be forwarded to the Chief Chemist, Box 927, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

JUNIOR CHEMIST REQUIRED BY WELLknown N.W. London manufacturers of cellulose and synthetic lacquers, etc. Previous experience in the development and formulation of synthetic finishes is desirable, though not essential. The post offers good opportunities for advancement to an enthusiastic worker. The company operates a five-day week, and a salary of up to £400 per annum, according to age and experience, is envisaged. Applications, giving full particulars of career and experience, should be forwarded to the Chief Chemist, Box 926, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

PHYSICS GRADUATE REQUIRED IN Mitcham Research Laboratory of the Philips Group of practical and interpretation work on *x*-ray crystallography. Some experience in this field preferred. Also Laboratory Assistant in the same field, capable of making minor alterations to equipment as required for unusual research problems. Apply in writing, giving age and experience, to the Works Personnel Manager, Mitcham Works, Ltd., New Road, Mitcham Junction, quoting the reference M.1/54 (Graduate) or M.1/48 (Assistant).

ENTOMOLOGIST REQUIRED BY INDUStrial firm (London area) manufacturing insecticides and fungicides. Applicants should possess an honours degree and should have had extensive field experience in the use of such products. Research experience would also be an advantage. Salary not less than £800 per annum, but would depend upon qualifications, experience, etc. Write to Burt, Boulton and Haywood, Ltd., Brettenham House, Strand, W.C.2. Applications treated in confidence.

MANUFACTURERS OF CEREAL PRODucts have vacancies in central laboratory (about fifty miles from London) for (1) young male graduate Physical Chemist or Physicist with some strength in chemistry; (2) young male graduate Chemist with some specialized training in agricultural chemistry. Commencing salary in each case is not likely to be less than £400, with yearly increments. Full details to Box 924, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

PHYSICIST REQUIRED AS ASSISTANT IN the works laboratory of a large firm in S.E. London to carry out physical (including electrical) investigations in connection with development, testing, and factory control. Degree and some industrial experience essential. Salary, including war allowance, between £400-£500 per annum. Applications, with full details of education, qualifications, and experience, to be sent to Box 925, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

MATHEMATICIAN, AGED 22-30, PR ably with some training in statistics, requi mathematical investigations. Candidates have good qualifications. Salary will gener in accordance with the Government White on the Scientific Civil Service. Candidates apply by letter only, giving full particulars qualifications, and any experience, to Briti lated Callender's Cables, Ltd., Research ment, 38, Wood Lane, Shepherds Bush, W.12.

LABORATORY TECHNICIAN (GRA (male or female) required for Chemistry ment, to commence duties June 30. Sala by £15 to £345. Candidates possessing F.I.M.L.T. or its equivalent will be grad salary purposes two years' seniority. Supe tion. Applications, stating age, qualificatio vious experience, together with names and ad of two referees, should be sent immediately Secretary, Medical School, Guy's Hospital, Bridge, S.E.1.

IMPERIAL CHEMICAL INDUSTRIES, Dyestuffs Division, require for their cen staff at Blackley Works, Manchester, C Physical Chemists, and Technologists for r and development of dyestuffs, pigments, po detergents, for the textile, paint, printi leather, and paper industries. Minimum ac requirement B.Sc. second-class honours. A 35. Salary according to age and experience. cations in writing to I.C.I., Ltd., Centra Department, 2, Grosvenor Place, S.W.1.

IMPERIAL CHEMICAL INDUSTRIES, Dyestuffs Division, require for their cen staff at Blackley Works, Manchester, P for research work on the fundamental pr of new synthetic fibres. Minimum acade quirement first-class honours degree. Age li Salary according to age and experience. A tions in writing to I.C.I., Ltd., Central St partment, 2, Grosvenor Place, S.W.1

THE MOTOR INDUSTRY RESE Association has a vacancy in the Informati tion for a Technical Abstractor. Candidates have a degree in engineering or its equival a sound knowledge of French and German, up to £500 per annum, according to qualifi and experience. Superannuation provision the Federated Superannuation System for sities. Applications to be sent to the D Motor Industry Research Association, West Road, Brentford, Middlesex.

THE BRITISH SCHERING RESEARC stitute, Brook Lane, Alderley Edge, Ches vite applications for posts as Research C for work in chemotherapy. Applicants shou research experience. Replies, giving full together with salary required, should be the Director of Research not later than J 1947.

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